AERONAUTICAL ENGINEERING REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

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DECEMBER 1946

PRECISION PRODUCTS
AND
ENGINEERED SYSTEMS
FOR AIRCRAFT

● Keeping tabs on a red-hot hurricane best describes the activities of these G-E engineers. They're checking an instrument panel in the pressurized chamber of a B-29, G.E.'s Flying Laboratory. The instruments are connected to various parts of a gas turbine, the TG-180, which has been installed in a bomb bay of the giant plane. In this manner, accurate records can be kept of actual flight performance of this G-E development, and adjustments made without danger to personnel.

Center of this development work is the G-E Flight-test Division which was recently dedicated at Schenectady. Besides the huge hangar, there are offices for engineers, a workshop where parts are made, and space for development work on all types of air borne equipment. Here, work begun under the impetus of war years has not slackened on equipment useful in commercial aviation. Here, too, problems connected with new planes of all types can be studied and equipment flight tested. Remember, General Electric is working on electric power systems (a-c and d-c), aircraft instruments, gas turbines, and many other devices. Perhaps we have the answers to your electrical problems. Our engineers will be glad to discuss them with you. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

674-63C-8872

Cover—First official flight view of the 139-ton Consolidated Vultee B-36

AERONAUTICAL ENGINEERING REVIEW

Vol. 5 December, 1946 No. 12

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Published Monthly by the Institute of the Aeronautical Sciences, Inc.

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SUBSCRIPTION RATES

Aeronautical Engineering Review: United States and possessions, 1 year, $3.00; single copies $0.30. Foreign countries including Canada (American Currency Rates), 1 year, $3.50; single copies, $0.35.

Entered as second-class matter at the Post Office, Easton, Pa., April 29, 1942. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

Publication Office: 20th & Northampton Streets, Easton, Pa.

Editorial Office: 2 East 64th Street, New York 21, N.Y.

Notices of change of address should be sent to the Institute at least 30 days prior to actual change of address.

Statements and opinions expressed in the *Aeronautical Engineering Review* are to be understood as individual expressions and not those of the Institute.

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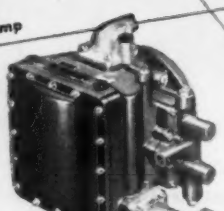
DOUGLAS DC-6 uses VICKERS 3000 psi HYDRAULIC EQUIPMENT

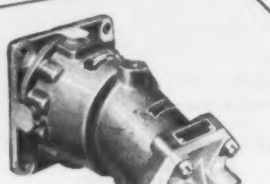
Vickers 3000 psi Motorpump

Vickers 3000 psi Constant Displacement Piston Type Pump

Vickers 3000 psi Accumulator



Vickers 3000 psi Variable Volume Piston Type Pump



Vickers 3000 psi Constant Displacement Piston Type Motor

Douglas Aircraft Company specifications for the 3000 psi hydraulic systems of the DC-6 include the Vickers units shown here.

In the main hydraulic system, the Vickers engine-driven Constant Displacement Type Pumps have exceptionally long life, low weight per horsepower, and very high volumetric and over-all efficiencies. The Vickers 7½" Accumulators assure maximum safety because of their forged construction; other important features are large capacity and light weight. The Vickers Motorpump serves as an additional hydraulic power source in emergencies enabling the pilot to give undivided attention to flight maneuvers.

The cabin pressurization system uses Vickers Variable Volume Piston Type Pumps which automatically deliver the power and speed variations required to maintain the desired cabin pressure independent of varying altitude and engine speed. The Vickers Hydraulic Motors have high starting and running torque. The very low inertia of their moving parts permits instantaneous starting, stopping and changes in running speed. They also have exceptionally low weight per horsepower, and are free from radio interference.

Vickers Bulletin 46-41 gives additional data about the most complete line of 3000 psi hydraulic equipment for aircraft. Write for a copy.

VICKERS Incorporated
DETROIT 32, MICHIGAN

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

I.A.S. News

A Record of People and Events of Interest to Institute Members

I.A.S. on Advisory Panel

Air Coordinating Committee Sets Up Aviation Industry Advisory Panel with Institute Representing Aeronautical Research. Caldwell Named as I.A.S. Panel Member.

THE INSTITUTE OF THE AERONAUTICAL SCIENCES accepted an appointment, on October 28, as a member of the Aviation Industry Advisory Panel of the Air Coordinating Committee. The Institute is to represent the interests of aeronautical research.

The Committee is composed of representatives of the State, War, Post Office, Navy and Commerce departments, the Civil Aeronautics Board, and, on a non-voting basis, the Bureau of the Budget. Its mission is, as indicated by its name, to coordinate all air activities of the Government. Provision has been made for the participation of other Government agencies when they have a substantial interest in matters under consideration by the Committee. The Committee has set up Industrial, Economic, and Technical divisions under the administrative direction of staff secretaries to assist the subcommittees in performing their functions.

The Panel was recently established by the Committee to participate in a consulting capacity in mutual problems concerning Government and industry. On September 19, the President of the United States, acting on advice of the Government agencies concerned with civil aviation, stated in his Order for reorganization of the original Air Coordinating Committee that "Aviation specialists, both in Industry and Government, have recognized the desirability of closer liaison between governmental and private activities in the aviation field."

Other organizations appointed to the Advisory Panel are the Aircraft Industries Association, Air Transport Association, the C.I.O., the A.F. of L., and the National Aeronautic Association.

The Institute selected, as its representative to the Panel, Frank W. Caldwell, 1941 President of the Institute and Director of Research for the United Aircraft Corporation. A graduate of Massachusetts Institute of Technology, Mr. Caldwell's aeronautical work began in 1916 as a specialist in propeller design with Curtiss Aeroplane & Motor Company in Buffalo. From 1917 to 1928 he was in charge of propeller development for the Army Air Service. In 1929 he became Chief Engineer of the Standard Steel Propeller Company and later Chief Engineer and Engineering Manager of the Hamilton Standard Propellers Division of the United Aircraft Corporation. He held this position until 1940, when he assumed direction of all research for the United Aircraft Corporation. Mr. Caldwell was selected as I.A.S. representative because of his breadth of outlook and long experience in aeronautical research.

Chairman of the Committee, Will Clayton, Undersecretary of State for Economic Affairs, and Co-Chairman, James M. Landis, Chairman of the Civil Aeronautics Board, report that the President's Order gives the Committee a broad responsibility in civil aviation and that the President expects the Committee to advise him on civil aviation policy matters.

Of the major problems that are now before the Committee, Mr. Clayton and Mr. Landis emphasized the importance of the following: early action in the PICAO to arrange for the installation of essential air-navigation facilities along international airways; the facilitation of air travel through the liberalization of customs, immigration, quarantine, and passport requirements; the coordination of Government policy with respect to the installation of electronic aids to air navigation along the Federal airways system.

The first meeting of the Aviation Industry Advisory Panel was held at the Commerce Building in Washington, D.C., on November 8.

Frank W. Caldwell.

I.A.S. Calendar

January 28–30, 1947	Fifteenth Annual Meeting, New York, N.Y.
March 28, 1947	Aircraft Propulsion Meeting, Cleveland, Ohio
May 26–27, 1947	Light Aircraft Meeting, Detroit, Mich.

For further details see page 97.

Third Annual I.A.S. Wright Field Tour

One Hundred Institute Members Inspect Laboratories and Flight Line Display. Lt. Gen. N. F. Twining Commends Group on Outstanding War Activities.

Lt. Gen. Nathan F. Twining, Commanding General of the Air Matériel Command, welcomed nearly 100 I.A.S. members to Wright Field on October 31 at the opening session of the Institute's third annual two-day inspection tour. General Twining commended the guests on their outstanding activities during the war. "I know of no other group that did so much to further the war effort or made more valuable contributions to the achievement of final victory." The ex-Commanding General of the 13th and 20th Air Forces continued: "It was a war which brought into prominence for the first time the scientist and the engineer as a fighter on par with gunners and bombardiers of our aircraft."

Major Gen. L. C. Craigie, Chief of the Command's Engineering Division, followed General Twining and outlined the plans and activities of the Engineering Division. He stressed the need for additional funds for research in general and for Wright Field in particular.

During the course of the tour Institute members inspected eight laboratories. The Aero Medical Laboratory described, with animated models and films, the effects of a pressure chamber "at altitude" suddenly being decompressed to sea-level pressure.

The Propeller Laboratory presented an exhibition of propellers, engines, and electric-motor whirl test facilities; equipment for testing component parts of propellers; and a display of experimental types of propellers and helicopter rotors submitted by manufacturers for test and eventual use on Army aircraft.

The Equipment Laboratory displayed its wide scope of operations ranging from 6,000-gal. gasoline trucks to 1/8-in. aircraft-instrument electric-light bulbs.

Recent developments in air-borne radar, beacons, fire-control systems, bombing aids, altimeters, tail-warning equipment, television, countermeasures, and radio control mechanism for A.A.F. projects were shown in the Electronic Laboratory.

After a visit to the Armament, Power Plant, Aircraft, and Photographic laboratories, the group moved to the Flight Line where they witnessed the Flight Test Division's static display of the latest military aircraft, followed by an aerial demonstration of American and foreign planes.

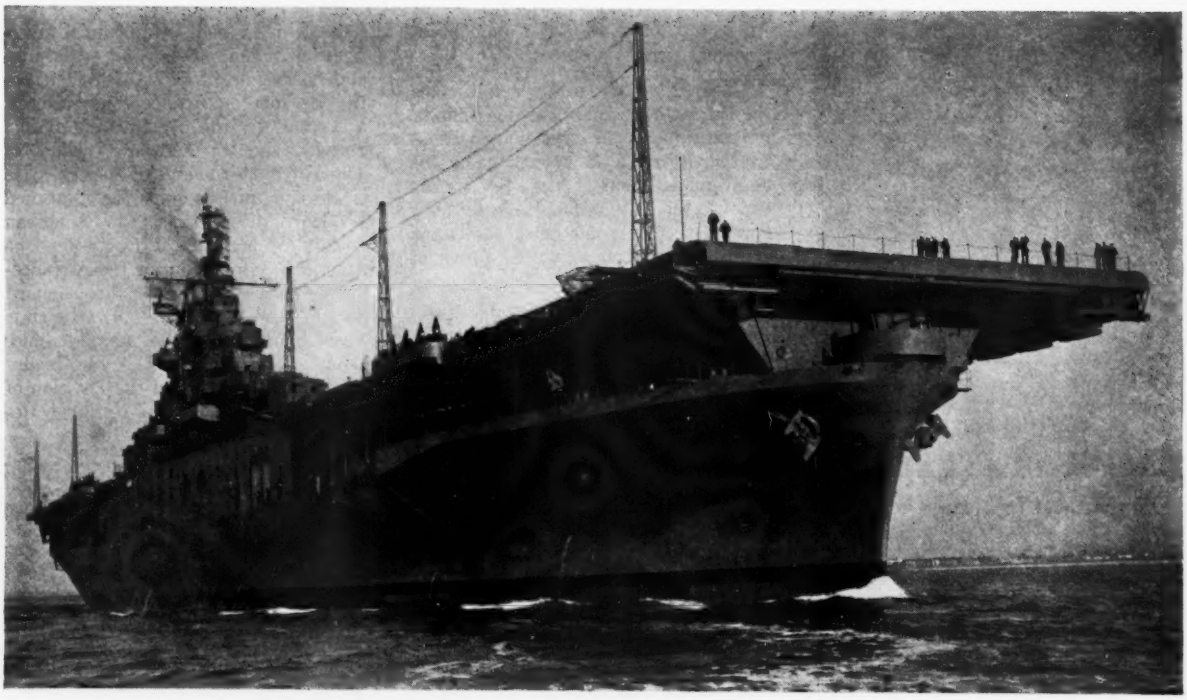
Among the events of particular interest were taxiing tests and loading and unloading procedure of a C-74 and a short demonstration of the Doblhoff helicopter, equipped with blade-tip jets. The aerial demonstration consisted of maneuverability tests of a Lockheed P-80; take-off of a JATO-assisted P-80; and a demonstration of a P-51 with two ram-jet engines mounted at the wing tips.

On the evening of October 31, the Institute entertained General Twining and his staff at a dinner held at the Orville Wright Officers' Club. The following were seated at the head table: Lt. Gen. N. F. Twining, Commanding General; Major Gen. Benjamin W. Chidlaw, Deputy Commanding Gen., Engineering; Major Gen. L. C. Craigie, Chief, Engineering Division; Brig. Gen. T. B. McDonald, Chief, Maintenance Division, Engineering; Brig. Gen. J. M. Weikert, Asst. Commanding Gen., Supply; E. A. Deeds, National Cash Register Company; The Honorable Edward Breen, Mayor of Dayton; Edward R. Sharp, National Advisory Committee for Aeronautics; E. E. Aldrin, Aviation Manager, Atlas Supply Company; Charles H. Colvin, Past-President, I.A.S.; Sherman M. Fairchild, Chairman of the Board, Fairchild Camera & Instrument Corporation; R. H. Fleet, Toastmaster; Earl D. Osborn, President, Edo Aircraft Corporation; L. B. Richardson, Executive Assistant to the President, Curtiss-Wright Corporation; S. Paul Johnston, Director, I.A.S.

Lieutenant General Twining, Major General Chidlaw, and Major General Craigie were the guest speakers.

. . . .the group pauses before a B-29 Superfortress long enough to have picture taken. . . .

Air Matériel Command Photo



Official U.S. Navy Photograph

. . . . the Navy plays host to Institute Members aboard U.S.S. "Boxer," Essex Class Carrier . . . .

Navy Stages Second I.A.S. Carrier Cruise

West Coast Group Witnesses Exhibition of Combat Tactics and Equipment Aboard U.S.S. "Boxer." Demonstrations Similar to Those on U.S.S. "Tarawa" off New York in April, 1946.

At 7:30 a.m. November 7, 140 members and guests of the Institute went aboard the U.S.S. "Boxer" at San Francisco for a demonstration cruise off San Francisco Bay. During the war this 27,500-ton Essex Class carrier served as a base for over 10,000 operational flights and logged a 70,000-mile steaming record. Her officers, pilots, and crew staged an all-day demonstration of naval, sea, and air equipment in operation under a wide range of conditions that gave the visiting I.A.S. aeronautical scientists and specialists a new insight into the problems of the Navy's air arm. The event was a fitting companion piece to the memorable cruise aboard the U.S.S. "Tarawa" last spring.

At a breakfast in the carrier's Ward Room, Rear Adm. Osborne B. Hardison, Commander of Carrier Division FIVE, welcomed the guests on behalf of the Secretary of the Navy. Admiral Hardison is one of the Navy's original "flying Admirals," with 23 of his 30 years of active duty with naval aviation. He expressed the Navy Department's interest and warm approval of such opportunities to exchange ideas and problems with aeronautical scientists and specialists. Demonstrations of this kind provide the Navy with a better understanding of the manufacturers' problems and acquaint designers and engineers with actual operating conditions, thus producing more efficient equipment. Admiral Hardison concluded that such cooperation was vitally necessary to further the technical progress of the country.

At 9:30 a.m. the ship was well at sea. After an inspection tour the guests watched an air group consisting of Grumman Hellcats and Avengers and Curtiss Helldivers take off into a 32-knot wind. They then witnessed simulated combat dive-bombing, strafing, and torpedo-bombing attacks on the ship.

An hour and a half after take-off the aircraft were taken aboard. The group of observers had an opportunity to observe carrier landing procedure and the arresting gear in actual operation.

In the afternoon, the group of F6F's, TBM's, and SB2C's took off again and demonstrated various battle tactics in a double attack on the carrier. After this second "battle" of the day the air group landed at Alameda Naval Air Station.

During the return trip to Alameda a tour was conducted of the 100-plane hangar deck, the 150,000-hp. engines, and the living quarters of the officers and men. Films were shown in the Ready Room at this time.

In the evening, the President of the Institute, Arthur E. Raymond, entertained Admiral Hardison and his staff at dinner in the Mural Room of the St. Francis Hotel in San Francisco. Present at the dinner were: Rear Adm. O. B. Hardison, Commander of Carrier Division FIVE; Capt. E. O. Burroughs, Chief of Staff for Admiral Hardison; Capt. R. N. Hunter, Commander of the U.S.S. "Boxer"; Lt. R. E. Seidell, Flag Officer; Arthur E. Raymond, President of the Institute; John K. Northrop, Advisory Committee, I.A.S.; Dr. Clark B. Millikan, Past-President, I.A.S.; and Bennett H. Horchler, Executive Vice-President, I.A.S.

Dr. H. K. Skramstad.

Dr. Skramstad Named Chief of Guided Missiles Section

Dr. H. K. Skramstad, Associate Fellow of the Institute, has been appointed Chief of the Guided Missiles Section of the National Bureau of Standards.

The Guided Missiles Section is concerned with the extended research and development of the advanced forms of guided missiles. This section played a prominent part in the development of the first fully automatic guided missile to be successfully used in combat, the radar-guided bomb known as the BAT.

Until the outbreak of the war, Dr. Skramstad was engaged in studies of wind-tunnel turbulence and the investigation of the stability of laminar flow. In 1942, he became Technical Assistant to the Associate Director of the Bureau, Dr. H. L. Dryden, Honorary Fellow of the Institute.

Medal of Freedom Awarded Dr. Dryden

Dr. Hugh L. Dryden, Associate Director of the National Bureau of Standards and an Honorary Fellow of the Institute, has been awarded America's second highest civilian decoration, the Medal of Freedom, for performing meritorious service with the Scientific Advisory Group in Europe from April to June, 1945. The citation states that Dr. Dryden ". . . . made an outstanding contribution to the fund of knowledge of the Army Air Forces with his research and analysis of the developments and use of guided missiles by the enemy."

As a member of the A.A.F. advisory group Dr. Dryden obtained invaluable information on the enemy's guided-missile projects and on their supersonic-missile research. He is now serving as Chairman of the Guided Missile and Pilotless Aircraft Panel of the Scientific Advisory Board to the Commanding General, Army Air Forces.

During the war, Dr. Dryden directed the Bureau of Standards' guided-missile program and made vital contributions to the Bureau's development of the radar-guided bomb, the BAT. As Chief of the "Kingfisher Project," he is now engaged in work being conducted at the Bureau on advanced forms of guided missiles.

Dr. Dryden is Editor of the JOURNAL OF THE AERONAUTICAL SCIENCES, is an Editor of the *Quarterly of Applied Mathematics*, and has contributed to scientific journals in the field of aerodynamics, properties of airfoils at high speeds, wind-tunnel investigations, wind pressure on structures, and turbulence. He is President of the Washington Academy of Sciences, a Fellow of the American Physical Society, and an Associate Fellow of The Royal Aeronautical Society. He is also a member of the National Academy of Sciences, the American Society of Mechanical Engineers, the American Association for the Advancement of Science, and the Philosophical Society of Washington. Dr. Dryden is Vice-Chairman of the Aerodynamics Committee of the N.A.C.A. and is also serving as a member of the Division of Engineering and of the National Research Council.

News of Corporate Members

New Corporate Member

Radioplane Company, located at the Metropolitan Airport in Van Nuys, Calif., a pioneer in pilotless-aircraft development in the United States, has recently become a Corporate Member of the Institute. Since the company was founded 7 years ago, it has been exclusively engaged in the design and fabrication of pilotless aircraft. Radioplane Company's principal officers are: President, Whitley C. Collins; Vice-President, Harold H. Powell; Vice-President—Engineering, Ferris M. Smith; Secretary, Reginald Denny; and General Manager-Treasurer, William Larrabee.

In 1939, after 5 years of intensive engineering and experimental work by the company's organizers, the first successful remotely controlled aircraft was developed in the form of an aerial target for the Army Air Forces. This aerial target was constructed of wood and fabric and cruised at approximately 50 m.p.h.

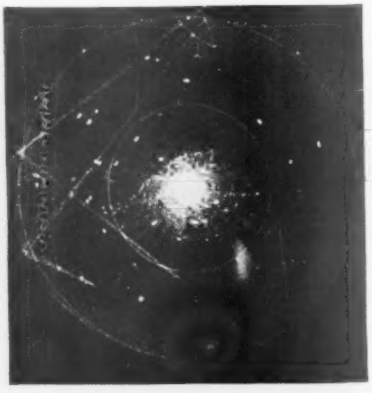
Further improvements followed the trend of high-speed aircraft to an all-metal monocoque fuselage which attains 250 m.p.h. Together with the evolution of the aircraft itself, Radioplane Company has assisted in the design of control and stabilization equipment, including; gyro-stabilization equipment, throttle control, and altitude control devices.

In keeping with the progressive spirit of the aviation industry, Radioplane Company has acquired an engineering staff consisting of specialists in the following fields necessary to pilotless-aircraft developments: power plant, stabilization, electronics, aerodynamics, structures, and design.

Distinguished Service Award to Sperry, Inc.

"Many problems of materials and construction, never before encountered, were successfully solved," said Chief of the Navy Bureau of Ordnance, Vice Adm. G. F. Hussey, Jr., on October 8, when he presented the Sperry Gyroscope Company, Inc., at its plant in Great Neck, Long Island, a Certificate for Distinguished Service to Naval Ordnance Development.

Preston R. Bassett, President of the Sperry Gyroscope Company, Inc., and a Fellow of the Institute, received the award for the company. Sixty-five Sperry employees were awarded lapel emblems for individual contributions to ordnance development.



This microwave-early-warning radar unit (M.E.W.), located at the Airborne Instruments Laboratory, Inc., at Mineola, N.Y., supplying a moving picture of air traffic as it normally flows through the New York area, was inspected on October 25–26 by PICAO delegates representing 38 foreign countries.

Sections and Branches

Buffalo Section

By Peter Tauson, *Secretary*

"Application of the Automatic Pilot to the Experimental Determination of Airplane Dynamic Stability and Control" was the subject of a paper presented in two parts by W. F. Milliken and E. V. Laitone at the October 24 meeting, held at the Statler Hotel. Mr. Milliken discussed the historic development of the airplane beginning with the period during which the design parameters were established empirically in order to determine their relation to various lifting and control surfaces of the aircraft.

The speaker pointed out that, as experience was acquired, certain values necessary for static stability were established, and design based on those parameters resulted in satisfactorily stable airplanes. However, as airplanes increased in size and speed, the old design, based on static stability alone, became insufficient and dynamic stability and maneuverability of the airplane became of prime importance. Design modifications were made as a result of flight testing in order to meet this higher performance requirement. It was stated that the Cornell Research Laboratory has undertaken an investigation of those parameters involved in dynamic stability of the airplane so as to predict the necessary design maneuverability parameters.

The second part of the paper was presented by Mr. Laitone, in which he traced the derivation of the basic dynamic equations of motion. He proceeded to show how differential equations of motion are derived and also how the stability parameters for the airplane can be found from these differential equations through constants determined by experimental flying.

A discussion followed this paper and the meeting was closed by Chairman Dexter Rosen.

Hagerstown Section

By George I. Hackenberger, Jr., *Acting Chairman*

Sam A. Gordon, The Glenn L. Martin Company's Chief Test Engineer, described the Martin PBM-3 wing destruction test at the October 17 Section meeting, held at the Washington County Museum, City Park, Hagerstown, Md. Two films and a series of slides on the subject were presented.

Los Angeles Section

By G. R. Melinger, *Secretary*

On October 15, 120 members and guests were present to hear Chairman C. L. Johnson introduce the two honor guests for the evening, Professor Pawlowski, formerly of the University of Michigan and now consultant for Douglas Aircraft Company, Inc., and Bennett H. Horchler, Executive Vice-President of the Institute.

Mr. Johnson announced, for the benefit of those members who might not have been aware of it, that William H. Dudley, Pacific Coast Executive of the Institute, had passed away several weeks previously. The loss of Mr. Dudley will be greatly felt in the activities of the Los Angeles Section and the Pacific Aeronautical Library. One of the reasons for Mr. Horchler's visit to the Coast at this time is to assume some of Mr. Dudley's duties temporarily and to work on the problem of obtaining a successor.

Mr. Johnson stated that, although plans were completed and the money available to construct the new Institute building, no permission has as yet been obtained from the Government to construct such a building and that he therefore regretted the necessity of announcing no progress. It is hoped that permission can be gained for building before costs exceed the money on hand.

It was announced that the "one-day" airplane carrier cruise, planned by the Navy for Institute members, was likely to occur some time in November. Approximately 150 to 200 men of the local section will be shown an exhibition in carrier tactics. A quota system has been set up whereby each concern can send a number of delegates based on the percentage of local Institute members employed by them.

It was announced that the next meeting will be held on November 20, at which time A. L. Klein will deliver a lecture on his experiences at Bikini Atoll during the atom bomb experiments.

Chairman Johnson then introduced the program chairman for the evening, W. Klikoff, Chief of the Airframe and Appliances Section of the C.A.A., Sixth Region. Mr. Klikoff announced his program for the evening and introduced the speaker, G. Haldeman, Chief of the Aircraft and Components Section of the C.A.A. Mr. Haldeman in his lecture outlined the procedure and policies of the C.A.A. in flight testing an airplane to obtain an approved-type certificate. He interspersed his talk with a number of personal anecdotes from his colorful career in aviation. Since Mr. Haldeman is a pilot with long experience he was qualified to speak on almost any type of aircraft.

Jim Ross, Chief Aerodynamic Analyst of the local C.A.A. office, outlined the various parts of the C.A.A. regulations that govern the determination of allowable configurations, gross weight, center of gravity, and flap positions in obtaining an approved-type certificate. For instance, he pointed out that certain of the rate-of-climb requirements usually determined the maximum allowable gross weight, whereas the controllability and trimmability of the airplane usually determined the maximum allowable forward center-of-gravity position. Stability requirements usually govern the determination of the aft c.g. limit.

At the close of Mr. Ross's lecture, the meeting was thrown open to discussion and a large number of questions and answers were tossed back and forth between the audience and the lecturers. The questions were particularly appropriate, since a large number of Lockheed and Douglas Aircraft engineers were present who have had a great deal of experience with C.A.A. regulations and with C.A.A. flight testing.

Miami Section

By C. R. Ursell, *Vice-Chairman*

The following officers have been elected for the current year: Chairman, R. C. Zinn; Vice-Chairman, C. R. Ursell; Secretary-Treasurer, C. P. Liljengren; Advisory Board, B. C. Stephens.

New York Section

By Otto E. Kirchner, *Secretary*

The second Section meeting of the 1946–1947 season was held at Hunter College on October 15 with some 350 members and guests attending for the presentation of two papers by Joseph Cannon and Comdr. Martin V. Kiebert.

Both of these papers discussed development and actual flight tests of pilotless aircraft. Mr. Cannon described the Bell Aircraft development of equipment and flight-test procedures involved in producing a pilotless P-80 aircraft. The details of the installation were explained, and a movie was shown illustrating pilotless take-off, flight maneuvers, and landing procedures. The control of the pilotless aircraft was divided between a ground control station and a mother ship that flew alongside the pilotless aircraft. This type installation, as explained by Mr. Cannon, eliminated crew hazards in the determination of structural stresses in dive maneuvers. The ground control

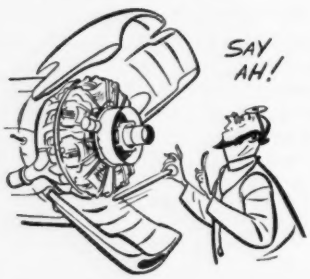
HANGAR FLYING

LOCKHEED

The Mechanical Mouth

It used to be like pulling teeth to get under an engine cowling. After a quarter-hour of yanking on rows of fasteners, you took down a truckload of Dural shingles. If you didn't lose or mash any under foot while you worked on the engine, you were lucky.

Now it's as simple as lifting the hood on the family bus. Lockheed engineers have worked out a new mechanical mouth for *Constellation* engines that opens up in two minutes flat. Unclasp and lift two small side panels, pull away the one-piece upper and lower hoods, and the engine's as bare as the tonsils of a six-year old saying "Ah!"



The giant metal jaws stay open obligingly, and completely out of the way. Prying engine medicos get plenty of elbow room and save precious minutes on routine inspections. And the mechanical mouth shuts just as fast. Out at Lockheed, the story goes, they took turns saying "Jack Robinson" in timing it.

Everybody that sees the mechanical mouth says it's just common sense. And it's this kind of common sense that gets all the green lights at Lockheed and keeps refinements in step with aviation progress.

L to L for L

© 1946, Lockheed Aircraft Corp., Burbank, Calif.

was at all times informed of the performance of the aircraft by a television portrayal of positions and readings of cockpit controls. With this arrangement and by means of installing strain gages, dives of increasing severity were performed to determine the wing loads for various types and degrees of dives.

Commander Kiebert explained the Navy's program for pilotless aircraft. This research consisted of developments as applicable to guided missiles. Commander Kiebert also explained that such aircraft were used for gunnery exercises and that he looked forward to the time when the same type of installation could be used for commercial air-cargo operation.

Both the Bell and the Navy systems used a 10-channel frequency-modulated system of the audio type. The use of the 10 channels and combinations of them allowed a control of approximately 20 airplane functions. Commander Kiebert presented slides of the specific equipment and movies showing take-offs and landings, also flight maneuvers as controlled from the ground station. The Navy program included research on predetermined pattern flying which involved setting the controls for a complete cycle of maneuvers prior to take-off. Difficulty was experienced in allowing for drift corrections for such predetermined pattern flying, resulting in a limitation of range of the aircraft to the visual distances from the mother ship or station. Kiebert also showed pictures of the type airplane used in the Bikini tests.

The talks invited considerable discussion from the floor, mainly on the problem of electronic controls replacing the human element.

Philadelphia Section

By Seymour Gottlieb, *Secretary*

At the October 15 executive-committee meeting, attended by the officers and advisory committee, H. Russel Young was appointed Philadelphia Section Representative on the Committee for Nomination of Area Councilors. Past-Chairman of the Section, F. G. Tatnall, was named Chairman of the Advisory Committee. H. J. Mulvey reported on the meeting of the Technical Societies Council of Philadelphia.

Aeronautical University

Two papers were presented at the October technical meeting. G. W. Schwandt, formerly of the A.F.T.S.C., spoke on the latest available methods of plastic construction, and L. M. Miller presented a paper outlining the graphic development of low-drag airfoils from a desired pressure-distribution standpoint.

An open-forum discussion was held following the speeches.

Alabama Polytechnic Institute

At a business meeting on October 21 a discussion of the purposes and benefits of the Student Branch was led by Chairman Frank Keown. Plans for the quarter's programs were discussed and approved. It was decided that the Student Branch would contract for a page in the 1947 Year Book.

University of Alabama

Forty-five members were present at the fall quarter's first scheduled meeting, October 15, in the University of Alabama's new Engineering Building, to hear Chairman William Podolny outline the objectives of the Student Branch and also lead a short discussion on the purposes and application of the Institute's publications. A film, *A Report on Jet Propulsion*, supplemented a discussion led by the Chairman concerning current national interest in jet propulsion. It was decided that regular meetings will take place every second and fourth Tuesday of the coming months. Twenty-one membership applications were received.

The Catholic University of America

Election of officers and the formation of plans for the new school year were the primary activities of this term's first formal meeting on October 16. A special N.A.C.A. film, dealing with the flow of air over models in a smoke tunnel, followed the business session. New officers are as follows: Chairman, Joseph Giovannetti Walsh; Vice-Chairman, Raphael Semmes Jones; Treasurer, Richard L. Caslin; Secretary, William Glen McLoughlin.

University of Illinois

At the first regular meeting of the fall semester, held in the Engineering Hall on October 8, the following became new officers: Chairman, Vernon E. Netherton; Vice-Chairman, Albert D. Swanson; Secretary-Treasurer, Charles C. Kelber. Twenty-seven new members were accepted into the Student Branch. It was decided to enter a group picture of the Branch and some descriptive material in the University Year Book.

Iowa State College

The following Student Branch members became officers in October at the first fall-semester meeting: Chairman, Roy C. Rogers; Vice-Chairman, James H. Foxgrover; Secretary-Treasurer, Whitney McCormack; Senior Engineering Council Representative, Russell

Helms; and Junior Engineering Council Representative, Dick L. Ditsworth.

University of Kansas

A combined technical and business meeting was held at Lindley Hall, October 10, under the direction of the newly elected Chairman, Billy B. Lash. Other new officers are: Vice-Chairman, Robert W. McJones; and Secretary-Treasurer, Whitson Godfrey, Jr. A talk outlining N.A.C.A. activities prefaced a general discussion of wind tunnels, subsonic and supersonic velocities, and compressibility effects at high speeds.

University of Michigan

"New Developments in Propulsion" was the title of a talk given at the first meeting of the semester on October 9, at which an attendance of 80 was recorded. A business meeting on October 23 was called to formulate plans for members of the Branch to attend the Cleveland Air Show, November 23. A suggestion was made to include a tour of the Cleveland N.A.C.A. laboratory at this same time.

Oklahoma University

At two meetings, held on October 2 and 17 at Oklahoma University's Engineering Building, new members were received and plans were made for the coming year.

Purdue University

On October 8, Chairman Merkel called the meeting to order and introduced the officers and faculty advisers to Branch members and their 90 prospective-member guests. Professor Bruhn talked on the history of the Institute, Professor Stanley welcomed the Air Transport students present, and Professor Rosenberg explained in more detail the position and function of the Branch. It was decided to hold meetings on the second and fourth Tuesday of each month. A suggestion was made that programs for these meetings should consist mainly of outside speakers and films on aeronautical subjects. Plans for the Senior Cord Parade at the Homecoming Game were discussed, and Al Knuthe, Student Senate Representative for the Aeronautical School, asked for subjects to be brought to the attention of the University.

Rensselaer Polytechnic Institute

Officers for the current semester are: Chairman, A. Zachow; Vice-Chairman, H. Cornelis; Secretary-Treasurer, R. Newton; Assistant Secretary-Treasurer, B. Van Dyke; and Honorary Chairman and Faculty Adviser, A. J. Fairbanks. Mr. Fairbanks, at the October 24 meeting, outlined the development and growth of the Institute and the aims and national meetings and described its various facilities and publications. Two films, *Cavalcade of Aviation* and *History of Naval Aviation*, were shown.

A. and M. College of Texas

The following officers were elected at a meeting on October 1: Chairman, Quinton C. Harvey; Vice-Chairman, Forrest E. Armstrong; and Secretary-Treasurer, Joe W. Coddou.

News of Members

William Joseph Allen, formerly Principal Engineer of the Navy's Bureau of Aeronautics, has become the Chief Electrical Engineer for the Eclipse-Pioneer Division of Bendix Aviation Corporation.

Harry C. Archer, ex-Test Engineer for Grumman Aircraft Engineering Corporation, is now Operations Manager for Caribe Airways, Inc.

Michael D. Bartholomew is now an Aerodynamicist at the Hamilton Standard Propellers Division of United Aircraft Corporation.

D. E. Batesole, Vice-President and Chief Engineer of the Norma-Hoffmann Bearings Corporation, has been appointed Chairman of the Ball and Roller Bearings Committee of the S.A.E. Technical Board.

Maurice Hubbard Bigelow has resumed his prewar position as Director of Technical Service at Libbey-Owens-Ford Glass Company, Plaskon Division.

Walter Kenneth Bullivant has joined Consolidated Vultee Aircraft Corporation as a Flight Test Analyst. He was formerly with the Grumman Aircraft Engineering Corporation.

Edwin J. Burnell has become Assistant Project Engineer at Fairchild Engine and Airplane Corporation, Pilotless Plane Division.

Capt. Charles Stahle Butt, Jr., U.S. Army, who served as Chief of Airplane Sub Unit, Air Technical Service Command, with the U.S. Army Air Forces, is now with the Design Coordination Branch of Office for Research, Development and Engineering, Bureau of Aeronautics, Navy Department.

William Henry Colcord, former Designer and Administrative Engineer at Kellett Aircraft Corporation, has now joined the Franklin Institute Laboratories for Research and Development as Aeronautical Engineer.

Alfred LaVerne Comp has returned to the University of Oklahoma—this time, advanced to Head of the Department of Aeronautical Engineering. He has been Stress Analyst at Douglas Aircraft Company, Inc.

Karl T. Compton, President of the Massachusetts Institute of Technology, was selected as one of ten scientists who are to become members of a civilian atomic research advisory committee.

Richard Morrison Coulston, formerly with Consolidated Vultee Aircraft Corporation, is now a Designer at El Segundo Division, Douglas Aircraft Company, Inc.

Robert Cooper Curry, discharged U.S. Army Air Forces' Lieutenant, is a Time Study Engineer with American Overseas Airlines, Inc.

Hans Rudolph Dettwyler is now Junior Engineer in the Rocket Research Department of the Propeller Division at Curtiss-Wright Corporation.

Maynard Glenn Douglass is a Gas Turbine Detailer at the Pratt & Whitney Aircraft Division, United Aircraft Corporation.

William Calvin Drake, Jr., former Engineering Draftsman with Douglas Aircraft Company, Inc., has transferred to North American Aviation, Inc., as a Stability and Control Aerodynamicist.

William M. Duke, formerly Assistant Department Head at Cornell Aeronautical Laboratory, has been advanced to the position of Pilotless Aircraft Manager.

Victor Emanuel, Chairman of the Aviation Corporation, has resigned from the boards of General Aniline & Film Corporation and the General Dyestuffs Corporation.

Thomas Urban Engelman is now an Engineering Instructor at the California Aero Technical Institute.

W. R. Enyart, Chairman of the N.A.A. Board of Directors and President of Simmonds Aerocessories, Inc., of New York, was elected Vice-President of the Federation Aeronautique Internationale at its first postwar meeting held in London early in September.

Garvin L. Von Eschen has recently been appointed to head Ohio State University's new Department of Aeronautical Engineering. He will direct the entire aviation program on the campus, which includes instruction at the Ohio State airport, transportation management, and various research projects dealing with aviation.

Douglas Erling Fahlen has been appointed Research Laboratory Analyst at Hughes Aircraft Company.

Sherman M. Fairchild has announced his resignation as Chairman of the Board of Directors of Fairchild Engine and Airplane Corporation. He is Chairman of Fairchild Camera & Instrument Corporation, President of Fairchild Aerial Surveys, and a Director of International Business Machines Corporation and Pan American Airways.

Irving Forsten is Junior Project Engineer at the Ranger Aircraft Engines Division of Fairchild Engine and Airplane Corporation.

James Gaz, former Liaison Engineer, Wright Aeronautical Corporation, has entered the U.S. Army Air Forces.

John Graves has joined the Aerodynamics Section of the El Segundo Plant, Douglas Aircraft Company, Inc.

Raymond Eugene Greenewald, prior to joining Frontier Aircraft Corporation as a Structures Engineer, was a Stress Analyst for Bell Aircraft Corporation.

Marvin Guss, ex-Waco Aircraft Company Engineer, is now a Designer for Ohmer Corporation.

Frank H. Hankins, Jr., was recently appointed Division Operations Manager of Pan American World Airways' Atlantic Division.

Richard Arthur Hirsch has become Research Engineer at Republic Aviation Corporation.

N. J. Hoff has been advanced to a Professor of Aeronautical Engineering at the Polytechnic Institute of Brooklyn.

Daniel Gerard Hoffman, 1st Lt., Air Technical Service Command, was awarded the Legion of Merit on October 4 for "serving with distinction in executing plans for the effective dissemination of aeronautical and related technical information to military and civilian research personnel."

Jack C. Jones, Curtiss-Wright Corporation's Experimental & Engineering Test Pilot, Airplane Division, has transferred to Jack & Heintz as Engineering Test Pilot.

L. B. Kalinowski, formerly Assistant Chief Engineer of Kellett Aircraft Corporation, is now associated in the same capacity with East Coast Aeronautics Inc., New York City. This change has necessitated Mr. Kalinowski's resignation as Chairman of the Philadelphia Section.

Girvis Erwin Ledbetter has joined the University of Washington, Department of Aeronautical Engineering, as a Research Fellow in Aerodynamics.

Robert W. Lilligren, formerly of Douglas Aircraft Company, Inc., has been named as Development Engineer of the Aviation Division of Wayne Pump Company, Ft. Wayne, Ind.

Carlos Benjamin Livers has become a partner in the Variety Development & Engineering Company.

Richard Hand Ludwick has joined the Structural Test Division of Boeing Airplane Company in Wichita, Kan.

Lance Eugene Martin, former Vice-President of W. K. Manufacturing Corporation, is now Chief Engineer and Plant Manager for S & M Manufacturing Company.

Mickel Alan Melkanoff, honorably discharged from the Army Air Forces, has been appointed Research Engineer, Consolidated Vultee Aircraft Corporation.

Louis Crossman Miller, former Head of Aerodynamics and Flight Test Section at Goodyear Aircraft Corporation, has transferred to Consolidated Vultee Aircraft Corporation as Aerodynamic Engineer.

Penn Evans Mullowney, Assistant Design Engineer for The Glenn L. Martin Company, is now Associate Professor of Aeronautical Engineering at the A. & M. College of Texas.

C. R. Smith, Chairman of the Board of American Airlines System, delivered the principal address at the Second Annual Arizona Aviation Conference in Phoenix, October 24–26.

George O. Noville has been named Vice-President and General Manager of National Skyway Freight Corporation, also known as the Flying Tiger Line.

Thomas Pinkney Peppler, newly appointed Chief Flight Test Engineer at McDonnell Aircraft Corporation, formerly held the same title with General Motors Corporation.

H. Conrad Poppenhusen has returned to North American Aviation as Instrumentation Designer in the Flight Test Group.

Milan Giles Reed is Engineering Assistant to the Director of the Academy of Aeronautics.

Janvier Mayhew Rice is the Engineering Planning Manager of the Ranger Aircraft Engines Division at Fairchild Engine and Airplane Corporation.

Paul E. Richter, Executive Vice-President of Transcontinental & Western Airlines, Inc., was named Managing Director of T.W.A.'s new transcontinental division.

Howard J. Rosan has rejoined Cornell Aeronautical Laboratory as Senior Mechanical Engineer, Special Projects Department. He was formerly Vice-President of Samuel D. Rosan Agency, Inc.

Sol Alexander Ross is Senior Aerodynamicist at Goodyear Aircraft Corporation.

Earl Rottmayer has joined the Aeronautics Department at Purdue University as an Instructor.

T. Claude Ryan, President of The Ryan Aeronautical Company, was elected Chairman of the Western Region Executive Committee of the Aircraft Industries Association.

Inz Rylski, former R.A.F. Flight Lieutenant, is now Stress Engineer at Canadair, Ltd., in Canada.

Henry Alfred Schroeder, M.D., is Associate Professor of Medicine at the Washington University School of Medicine in St. Louis, Mo.

George Henry Scragg, Director of Advertising and Sales Promotion of the White Motor Company, was elected President of the Early Birds for the current year.

George Llewellyn Shue has joined the Naval Ordnance Laboratory at Washington, D.C., as Chief of the Aerodynamics Subdivision. He was formerly an Aerodynamics Engineer at Consolidated Vultee Aircraft Corporation.

Will C. Sievert is Air Safety Investigator of the Safety Bureau of the Civil Aeronautics Board.

Lomis Slaughter, Jr., is Chief Engineer for Anderson Greenwood & Company.

Samuel Evans Slaymaker, III, is a Research Engineer for Bell Aircraft Company.

Richard Bruno Smietanski is Engineer and Die Designer at Doehler-Jarvis Corporation.

Stanley Stephenson Soult is an Aircraft Engine Mechanic for United Air Lines' Pacific Operations.

Gen. Carl Spaatz, Commander of the Army Air Forces, received an honorary degree of Doctor of Laws on October 12 at Williams College.

James Branyon Springfield is General Manager for Indiana Air Service, Inc.

Lawrence Rodney Stumpf is a student at the Massachusetts Institute of Technology.

Frank Louis Suozzi has joined the Cornell Aeronautical Laboratory as an Aerodynamicist.

Kenneth F. Thomas, formerly of SKF Industries, has established his own business as District Engineer for various manufacturing companies.

Homer Spencer Thomason, Jr., is now Stress Analyst (Static Test) for North American Aviation, Inc.

Gale Eugene Thompson is now a Structural Design Engineer at Beech Aircraft Corporation.

Jules Richard Titus is a Junior Engineer at Aeronca Aircraft Corporation.

Harold R. Uhrich, former Chief Engineer at Sensenich Brothers, is now Chief Analytical Engineer for the Aeromatic Aircraft Propeller Department of Koppers Company, Inc.

Robert Gordon Urquhart is Assistant Professor in Aeronautics at the University of Minnesota.

John Carlton Ward, Jr., President of Fairchild Engine and Airplane Corporation, was appointed Vice-Chairman of the Eastern Region Aircraft Manufacturers Council of the Aircraft Industries Association.

David Gene Whinery is a Graduate Student in Aeronautical Engineering at Purdue University.

Merritt A. Williamson, recently honorably discharged from the Navy, has been appointed Head of the Technical Research Department of Solar Aircraft Company, San Diego, Calif.

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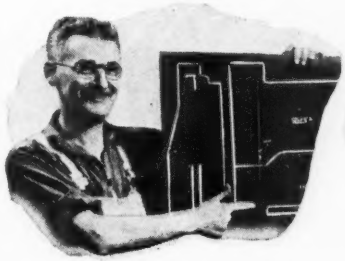

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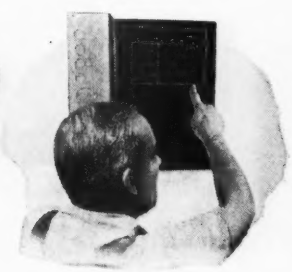

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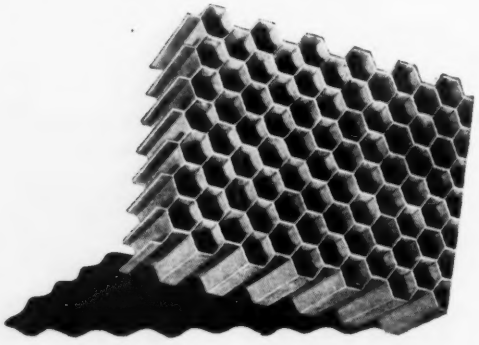

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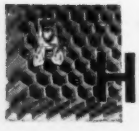

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Eugene Edward Wilson, Vice-President of the Manufacturers Aircraft Association, recently resigned his position as Vice-Chairman of the United Aircraft Corporation Board but will continue as a Director.

James Alan Wolfson is Special Projects Engineer for the Pan American Airways System.

Warren George Yoder is now Graduate Research Assistant at the University of Michigan.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Sweetser, Converse Wentworth, B.S. in Ae.E.; Asst. Chief of Structures, Grumman Aircraft Engineering Corp.

Elected to MEMBER Grade

Adams, Harold William, Design Engineer, Douglas Aircraft Co., Inc.

Ayers, John Edward, Sr., B. of Arts; Weight Control Group Engineer, The Ryan Aeronautical Co.

Baird, Nelson Anderson, Asst. Administrative Engineer, Douglas Aircraft Co., Inc.

Braun, Arthur, B.M.E.; Head of Hydraulics Unit, Equipment Section, Airframe & Equipment Div., Aircraft & Components Service Engineering, C.A.A. (Washington, D.C.).

Browne, Sidney Hamilton, Ph.D.; Research Engineer, North American Aviation, Inc.

Brueckner, John Daniel, B.S. in Ae.E.; Structural Engineer, Douglas Aircraft Co., Inc.

Cummings, Jerry Wickham, B.S.; Prof. of Aerodynamics, Aeronautical University.

de Faria Lima, Jose Vicente, Chief—Asst. Air Attaché, Brazilian Aeronautical Commission (Washington, D.C.).

Dewell, Harlan Alfred, B.S., Designer "A," Wing Group Lead Engineer, Northrop Aircraft, Inc.

Dong, James Collin, B.Ae.E.; Chief Engineer, Millar Instrument Co., Inc.

Drake, Daniel Webster, B.S.; Research Engineer, Lockheed Aircraft Corp.

Evans, Floyd Evan, B.S.; State Director of Aeronautics, State of Michigan.

Fisk, Melvin, B.S.; Stress Analyst, Aero Loads Group, North American Aviation, Inc.

Flatau, Howard Clarence, Lt. Comdr., Industrial College of the Armed Forces, Army War College.

Gayler, Noel Arthur Meredyth, B.S.; Comdr., Asst. Director for Aeronautics, U.S. Navy.

Goodpasture, Robert Abraham, B.S.; Hydraulic Research Analyst, Douglas Aircraft Co., Inc.

Gore, William Lee, Eastern Engineering Representative, Aerojet Engineering Corp.

Gurney, Theodore, B.S. in Ae.E.; Chief, Eastern Field Engineering, United Aircraft Corp.

Harned, Malcolm Stuart, B.S. in M.E.; Stress Analyst, North American Aviation, Inc.

Hart, Thomas James, B.S. in Ae.E.; Stress Analyst "A," Northrop Aircraft, Inc.

Hertenstein, Harold Nelson, M.S.; Instructor in Mathematics, Parks College of Aeronautical Technology.

Hopper, Rea Earl, B.S. in M.E.; Chief Engineer, Hughes Aircraft Co.

Jones, Rhys Paul, B.S.; Engineer, Lanier Aircraft Corp.

Kaliher, Eugene Charles, Weight Control Engineer, Douglas Aircraft Co., Inc.

Krause, Norman A., Chief Data Analyst and Senior Research Engineer, McDonnell Aircraft Corp.

Lansing, Neal Fisk, Jr., B.A.; Development Engineer, Aerodynamics Div., Research & Development, Elliott Co.

Levier, Anthony William, Chief Engineering Test Pilot, Lockheed Aircraft Corp.

Limouze, Charles Anderson, Ae.E.; Staff Engineer, Experimental Engineering Div., Bendix Aviation Corp.

MacLachlan, John Roxburgh, M.S. in Ae.E.; Lt. Comdr., Arresting Gear Technical Officer, Naval Air Material Center (Philadelphia, Pa.).

Mallett, Frank McLean, A.B.; Research Engineer, Airplane Div., Curtiss-Wright Corp.

Marcy, Clayton Clifton, B.S.; Capt., U.S. Navy.

Mehle, Roger William, B.S.; Comdr., Head, Chance-Vought, Goodyear-Ryan Section of Fighter Design, U.S. Navy.

Moser, Charles Nicholas, B.S. in Ae.E.; Aeronautical Engineer, Intelligence Div. (Wright Field).

Murphy, Glenn, Ph.D.; Prof. of Theoretical & Applied Mechanics, Iowa State College.

Murphy, Joseph Nathaniel, M.S. in Ae.E.; Capt., Director—Armament Division, Bureau of Aeronautics, Navy Dept.

Muse, Thomas Calvert, B.S. in M.E.; Aerodynamicist, Douglas Aircraft Co., Inc.

Needham, Robert Addison, B.S. in M.E.; Stress Analyst, North American Aviation, Inc.

Prince, Robert Knott, Jr., B.S. in Ae.E.; Stress Analyst, Lockheed Aircraft Corp.

Quick, Leonard Hunt, Asst. Project Engineer, Douglas Aircraft Co., Inc.

Ralston, Frank Marion, B.S.; Lt. Comdr., U.S. Navy.

Randels, William Conrad, Ph.D.; Aeronautical Engineer (Aerodynamics), North American Aviation, Inc.

Scherrer, Robert Elmer, B.Sc., C.E.; Stress Analyst, Douglas Aircraft Co., Inc.

Schrein, Norman F., B.Ae.E.; Chief, Controlled Equipment Branch Test Unit, U.S. Army Air Forces.

Segal, Robert Louis, B.Ae.E.; Structural Engineer, Supervisor, Landing Gear Structures, North American Aviation, Inc.

Tomamichel, Jack Jones, Ae.E.; Comdr., U.S. Navy.

Vazsonyi, Andrew, Ph.D.; Engineer, Aerophysics Lab., North American Aviation, Inc.

Weissman, Clem Coleman, B.S. in M.E.; Aeronautical Engineer, Bureau of Aeronautics, Navy Dept.

Weldon, Albert Roth, M.S. in Ae.E.; Comdr., Bureau of Aeronautics, Navy Dept.

Williamson, Ian Murray, B.A.Sc.; Research Lab. Analyst "A," Douglas Aircraft Co., Inc.

Wisehaupt, Darwin McConnell, B.S. in E.E.; Comdr., Assembly and Repair Officer, Bureau of Aeronautics, Navy Dept.

Wood, Homer Jesse, M.S.; Project Engineer, AiResearch Manufacturing Co.

Woodard, George Hatfield, M.E.; Manager, Aviation Gas Turbine Div., Westinghouse Electric Corp.

Zeigler, Samuel J., M.S.; Resident Chief Engineer, Solar Aircraft Co.

Transferred to MEMBER Grade

Meyerhoff, Leonard, M.Ae.E.; Aerodynamicist, Curtiss-Wright Corp.

Seidman, Oscar, M.Sc.; Principal Aeronautical Engineer in Aerodynamics and Hydrodynamics Branch, Bureau of Aeronautics, Navy Dept.

Smith, Ronald Henry, B.S.; Laboratory Research Analyst, Northrop Aircraft, Inc.

Elected to Associate Member Grade

Eyberse, John, Maintenance Div., Property Officer, Oklahoma City Air Technical Service Command.

Gibson, Weldon Bailey, M.B.A.; Lt. Col., Dean, U.S. Army Air Forces Institute of Technology.

Hunt, John Conway, LL.B.; Lt. Comdr., Head, Contract Termination Records Section, Bureau of Aeronautics, Navy Dept.

Lambert, Anatole Mitchell, Senior Inspector, Boeing Aircraft Co.

Roberts, Darrell Dean, Asst. Shop Foreman of Metal Shop, Pan American World Airways.

Thompson, Robert E., Sales and Asst. General Manager, North American Airport Corp.

Tryon, George Henry, III, B.A.; Engineer, National Fire Protection Assoc.

Elected to Technical Member Grade

Block, David Sidney, B.S. in Ae.E.; Instructor, The Aeronautical University, Inc.

Curione, Russell.

Elliott, Sylvia Rosslyn Bedrick, B.S.; Research Analyst, Douglas Aircraft Co., Inc.

Genta, John Louis, Lt. Comdr., U.S. Navy.

Hackett, Hugh Jerry.

Jones, Beverly Broaddus, Layout "A" Draftsman, The Glenn L. Martin Co.

Lengsholz, Allen Joseph, B.S.; Mathematician, North American Aviation, Inc.

Peter, Maurice Albert, B.Ae.E.; Aerodynamicist, The Glenn L. Martin Co.

Smith, Burton Henry, Layout Draftsman, Class 1, Bell Aircraft Corp.

Tackett, James Bernard, B.S.; Draftsman "A," Douglas Aircraft Co., Inc.

Winograd, Lee, B.M.E.; Lt. (j.g.), U.S.N.R.

Transferred from Student to Technical Member

Alldredge, Joel William, Associate in Arts, Stress Engineer, Wichita Div., Boeing Airplane Co.

Amick, Willard John, B.S. in Ae.E.; Mechanical Engineer, P-1, A.A.F. Air Matériel Command (Wright Field).

Andrews, Wilbur Alton, B.Ae.E.; Mathematician, North American Aviation, Inc.

Brown, Robert Clinton, B.S. in Ae.E.; Asst. Aerodynamicist, McDonnell Aircraft Corp.

Chabot, James Vincent, S.B.; Ensign, Project Engineer, U.S. Navy.

Curry, Warren Henry, M.Sc.; Engineer, General Electric Co.

Davis, Robert Arthur, B.Ae.E.; Graduate Asst., New York University.

Donaldson, Greta Cameron, B.S.; Graduate Student, Massachusetts Institute of Technology.

Farkas, George Eugene, B.Ae.E.; Junior Engineer, Boeing Aircraft Co.

Feehery, Leo Thomas, B.S.; Mechanical Designer & Engineer, Magnecord Inc.

Galle, Kurt Robert, B.S. in Ae.E.; Graduate Student, Purdue University.

Ganz, Leonard Sherwin, B.Ae.E.; Graduate Assistant, New York University.

Gatineau, Robert Jean, B.S. in Ae.E.; Graduate Student in Aeronautical Engineering, Purdue University.

Gilbert, Arthur Charles, B.Ae.E.; Graduate Student in Aeronautics, New York University.

Green, Charles Henry, Jr., B.Ae.E.; Aeronautical Engineer, Grade P-1, Langley Mem. Aero. Lab., N.A.C.A.

Green, James Frederick, B.S. in Ae.E.; Jr. Structural Engineer, Airplane Div., Curtiss-Wright Corp.

Harrison, John Warren, B.S. in Ae.E.; Aeronautical Engineer, Columbus Plant, Curtiss-Wright Corp.

Heyvaert, John Caesar, B.S. in Ae.E.

Hiber, Edwin Howard, B.S. in Ae.E.; Mathematician, North American Aviation, Inc.

Howells, Frederick Whan, Detail Engineer, Wichita Div., Boeing Airplane Co.

Israel, Lester, B.Ae.E.; Aeronautical Engineer, P-1, Wright Field (U.S. Government).

Jaquet, Byron Maurice, B.S. in Ae.E.; Aeronautical Engineer, P-1, Langley Mem. Aero. Lab., N.A.C.A.

Kaden, George, B.Ae.E.; Performance Flight Test Engineer, Air Matériel Command (Wright Field).

Lieske, Hans Arthur, B.S. in Ae.E.; Research Lab. Analyst—Flight Mechanics Section, Douglas Aircraft Co., Inc.

Lo Presti, Paul Anthony, B.S. in Ae.E.; Graduate Student in Aeronautical Engineering, Cornell University.

MacDonnell, Richard Joseph, B.S. in Ae.E.; Ensign, U.S. Navy.

Mark, Robert Burton, B.S. in Ae.E.; Ensign, U.S.N.R.

Malvern, Donald, B.Sc.; Aerodynamicist, McDonnell Aircraft Corp.

Mix, John Martin, B.S.

Mock, Bernard Lee, B.S. in Ae.E.; Aeronautical Engineer, Columbus Plant, Curtiss-Wright Corp.

Ormsbee, Allen Ives, B.Sc. in Ae.E.; Graduate Student, College of Engineering, University of Illinois.

Pemberton, Donald Eugene, B.S. in Ae.E.; Engineer—Structures Dept. Columbus Plant, Curtiss-Wright Corp.

Provost, Emile Loyola, S.B. in Ae.E.; Ensign, U.S.N.R.

Romer, Murray Marvin, B.Ae.E.; Asst. Project Engineer, 20-ft. Wind Tunnel, U.S. Government (Wright Field).

Rosenberg, Henry Wayne, B.S. in Ae.E.; Engineering Draftsman, The Glenn L. Martin Co.

Rozzell, George McAllaster, Jr., B.S. in Ae.E.; Junior Engineer, Curtiss-Wright Corp.

Ryan, Eugene Potter, B.S.; Ensign, U.S.N.R.

Secada, Alberto, Jr. Engineer, Pan American-Grace Airways, Inc., Lima, Peru.

Snider, Donald Stephen, B.S. in Ae.E.

Treasure, William Worthington, B.S. in Ae.E.; Experimental Test Engineer, Pratt & Whitney Aircraft Div., United Aircraft Corp.

Tulin, Marshall P.

Vasavada, Priykant Avantilal, S.M.; Graduate Student, Massachusetts Institute of Technology.

Necrology

Dr. Sanford A. Moss

Dr. Sanford Alexander Moss, Fellow of the Institute, accredited with the development and adaptation of supercharging to aircraft engines and recognized throughout the world as an outstanding engineer, inventor, and scientist, died of a heart ailment at his home in West Lynn, Mass., on November 11.

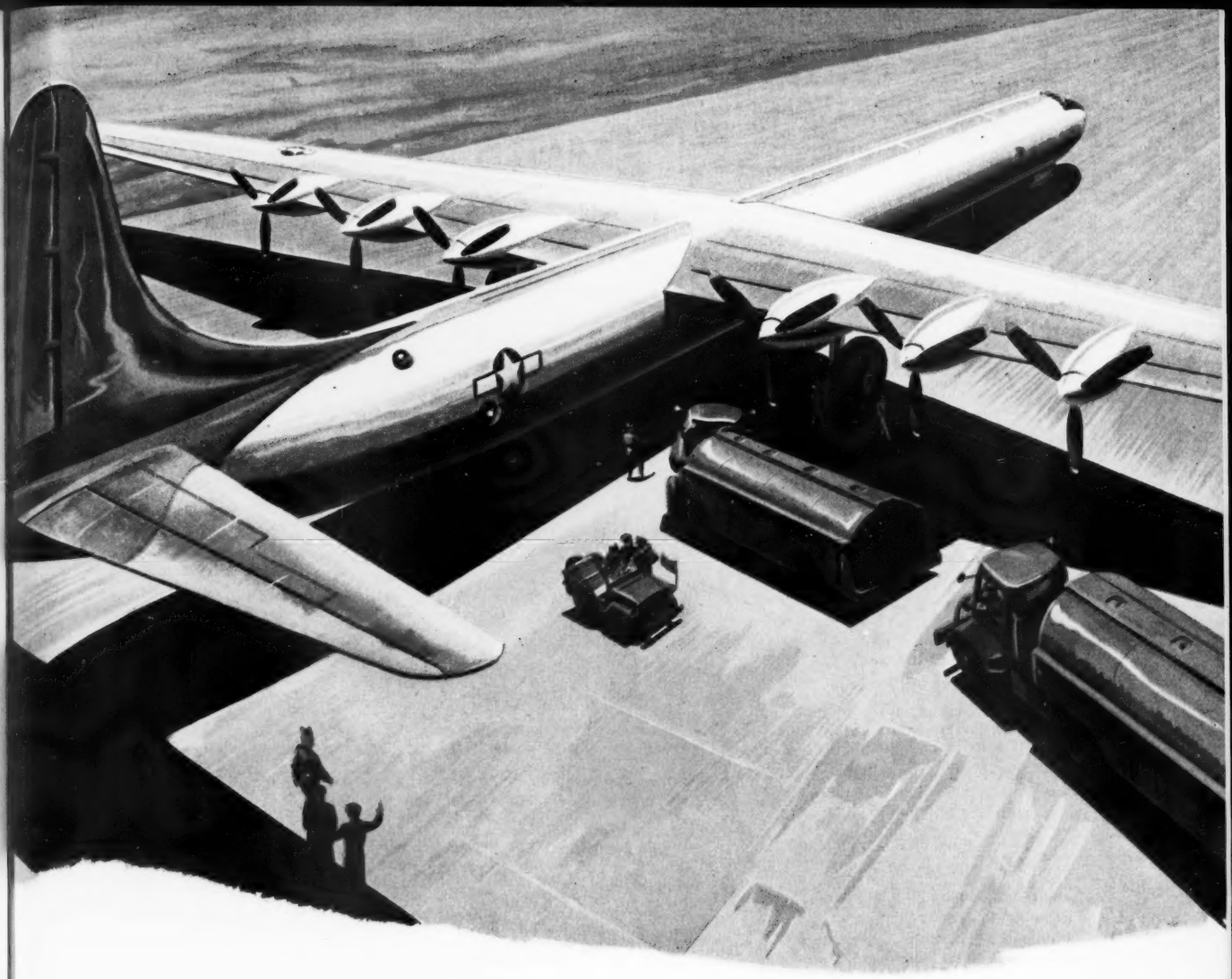
Dr. Moss was born in San Francisco on August 23, 1872. At 16, he was apprenticed at the General Electric Company as a mechanic. After completing a 4-year apprenticeship, he studied mechanical engineering at the University of California and received a B.S. degree in 1896 and an M.S. degree in 1900. From 1896 to 1898 he served as instructor in engineering at the University of California and occupied the same position at Cornell University from 1901 to 1903. A thesis on the subject of gas turbines earned him a Doctor of Philosophy degree at Cornell University in 1903 and a position with the General Electric Company as engineer in mechanical research. During the work on this project Dr. Moss developed a number of centrifugal compressors which found wide use in blast furnaces and iron foundries.

Dr. Sanford A. Moss.

Because of the success of his compressors and his gas turbine experience, Dr. Moss was one of the men to whom the N.A.C.A. turned for a solution of the problem of giving military planes greater power. His answer, worked out in cooperation with the Air Corps, was the now famous turbosupercharger.

In 1938, Dr. Moss went into what he thought would be retirement, but at the age of 67 he voluntarily resumed his work as consultant engineer for the General Electric Company. Two years later he received the 1940 Collier Avia-

(Continued on page 19)



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MINNEAPOLIS **Honeywell**

AERONAUTICAL CONTROLS

(*Continued from page 16*)

tion Trophy jointly with the Army Air Forces for "outstanding success in high altitude flying by the development of the turbosupercharger." Dr. Moss also received one of the General Electric Company's Coffin Awards for his supercharger work. He was given an Honorary Degree of Doctor of Laws by the University of California in 1943. During this same year he was presented The Sylvanus Albert Reed Award by the Institute of the Aeronautical Sciences in recognition of a notable contribution to aeronautical engineering.

Dr. Moss had 45 patents on superchargers, compressors, and other mechanical devices. He was a life member of the American Society of Mechanical Engineers and participated extensively in the work of other engineering societies and the American Standards Association.

I.A.S. Meeting Preprints

A limited number of copies of preprints of papers presented at meetings of the Institute are available for distribution, at a charge of 25 cents each to members of the Institute, and 50 cents to nonmembers, to cover handling and mailing charges. The following lists the preprints available from the past four national meetings of the Institute. Preprints may be ordered by number.

Aircraft Propulsion Meeting—Cleveland, Ohio, March 21, 1946

15. Application of Axial Compressors in Aeronautics—Ens. F. J. Gardiner, United States Naval Reserve, Navy Department, Bureau of Aeronautics. 11 pages; 8 illus. (Typewritten and photo-offset.)

Light Aircraft Meeting—Detroit, Mich., June 13–14, 1946

18. Maintenance of Personal Aircraft—George H. Weitz, Chief, Air Frame Section, Non-Scheduled Aircraft Maintenance Division, Civil Aeronautics Administration. 7 pages; no illus. (Mimeographed.)

Annual Summer Meeting—Los Angeles, Calif., July 18–19, 1946

20. Engineering Aspects of the Development of the Rainbow—Alexander Kartveli, Vice-President and Chief Engineer, Republic Aviation Corporation. 68 pages; 61 illus. (Vari-typed and photo-offset). *Available without charge from Republic Aviation Corporation.*

25. Design and Development of the Douglas B-42—Carlos C. Wood, Head of Preliminary Design, Santa Monica Engineering Division, Douglas Aircraft Company, Inc. 9 pages; 21 illus. (Photo-offset.)

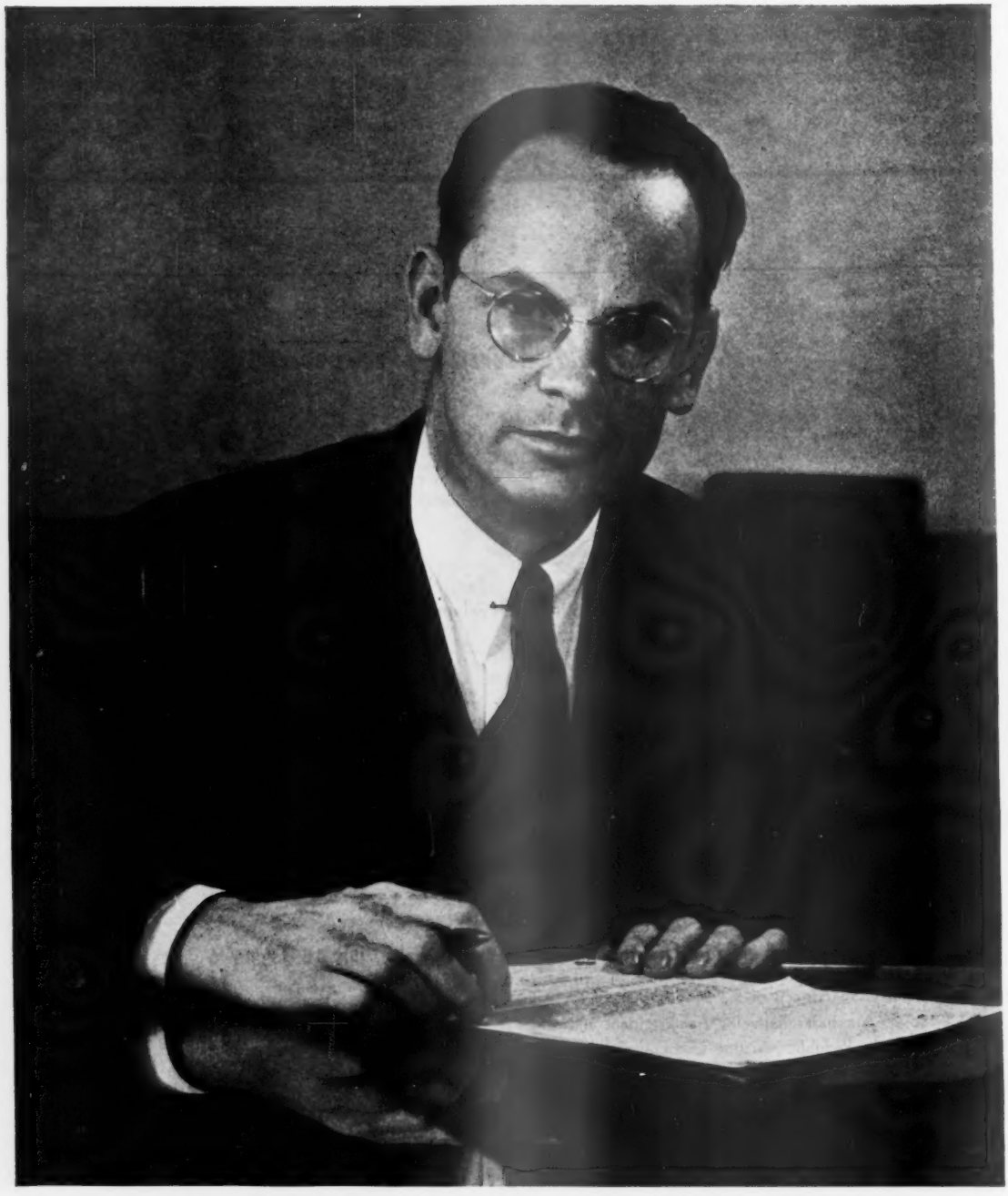
National Air Transport Meeting—Washington, D.C., October 24, 1946

26. The Application of Microwaves to Instrument Landing of Airplanes—Joseph Lyman, Aircraft Radio Research Engineer, Sperry Gyroscope Company, Inc. 34 pages; 27 illus. (Photo-offset.)

27. Development of International Standards for Airworthiness of Transport Aircraft—Paul A. Puvrez, Expert, Airworthiness Division, Provisional International Civil Aviation Organization (PICAO). 9 pages; no illus. (Photo-offset.)

28. Air Conditioning of Transport Aircraft for Year Around Comfort in Flight and on the Ground—Bruce E. Del Mar, Mechanical Test Engineer, Santa Monica Engineering Division, Douglas Aircraft Company, Inc. 10 pages; 10 illus. (Photo-offset.)

29. Teleran for Air Navigation and Traffic Control—L. F. Jones, Manager, Research & Development Projects, Radio Corporation of America. 24 pages, bound in covers; 17 illus. (Printed.)



During this year of transition the Institute has been fortunate in having a steady hand at the controls. President Arthur E. Raymond, of the Douglas Aircraft Company, has steered a competent course through a period made critical by uncertain industry conditions and a change of I.A.S. management.

Editorial

Year-End Roundup

This issue of the REVIEW marks the end of the Institute's fourteenth year of service to the aircraft industry of the United States. From a modest beginning in the postdepression years, it has paced the development of the aeronautical sciences, in war and in peace. Space here does not permit a review of its progress through the years, but a backward glance over the period just ending may well be worth while.

1946 has been a year of transition. Having survived the shock of abrupt termination of most of its wartime business in 1945, the aircraft industry has used the past 12 months to get its blood pressure back to normal, meanwhile piecing together the fragments of disrupted plants and organizations into some sort of pattern to cope with the immediate future. The rate of contraction was far greater than the rate of expansion; the resulting confusion, colossal.

The rapid change caught almost the entire industry with its income down, overhead up. The Institute was no exception. On one side of its ledger was a new building, plus increased expense to take care of a growing membership, plus steadily rising costs of paper, printing, and all other needed supplies. On the other side, revenues had declined with the general shrinkage of industry. The "war babies" among the Corporate membership dropped out, and the income from the REVIEW and the CATALOG took a downward trend. This combination of circumstances put the Institute into red ink for its fiscal year ending September 30. The amount of the deficit was not great, less than $5,000 on a $300,000 operation. The full details will be available when the audited treasurer's report for the year is published in an early issue of the REVIEW.

Thanks to the reserves that have been accumulated during the war years, however, the Institute's financial condition is far from precarious. Its special funds and its reserves have been wisely invested and are carefully controlled. But the red flag is up over "Operations" and your officers and Council have been hard at work since last spring, when the condition became obvious, to reduce unnecessary expense and to draw on reserves as little as possible. There are current indications that their efforts are already bearing fruit.

The Council has no view other than that the budget of the Institute shall be balanced as rapidly as possible. It has directed that management operate on a strictly "break-even" basis during fiscal 1947. The budget for the new year has been so drawn.

It is planned, however, that there shall be no curtailment of any of the services of the Institute to its members, individual or corporate. In fact, the Council has directed that all services to the membership be increased and improved by utilizing all facilities more effectively.

This is particularly important because we are now entering a period of technological revolution that makes the free interchange of information among the aeronautical engineers more essential than ever before. The advent of jet and rocket propulsion and the imminent probability of man-flight at supersonic speeds have posed new problems that will require the best of our collective skill and imagination to solve. As the open forum for the aeronautical profession, the Institute performs a vital function in the advancement of aviation in America.

The management of the Institute has accepted a dual obligation. It is doing everything in its power to carry the organization through this critical period on a sound financial footing and, at the same time, to keep ahead of the professional requirements of its membership. But it cannot do it alone. It must depend on the continued support of its members, both individual and corporate. By working together, the Institute can be maintained in a strong and healthful condition. It will continue to render more than value received to the industry it serves. *S.P.J.*

Cabins, Crashes, and Communications

Notes on the Program and Discussions of the I.A.S. National Air Transport Meeting

By J. PARKER VAN ZANDT*

ON OCTOBER 24, the day of the scheduled annual National Air Transport Meeting, the Washington strike-bound hotels were "socked in" with "zero-zero" meeting conditions. A successful "landing" was made, however, at a nearby alternate site, primarily through the help of C. Towner French, Vice-President of the Institute of Navigation.

S. Paul Johnston, Director of the Institute of the Aeronautical Sciences, opened the morning meeting in the auditorium of the U.S. Chamber of Commerce and introduced the Chairman, Charles Froesch, Chief Engineer of Eastern Air Lines. Bruce E. Del Mar, Mechanical Test Engineer of the Douglas Aircraft Company, read the first paper, on "Air Conditioning of Transport Aircraft for Year Around Comfort in Flight and on the Ground."

Mr. Del Mar first reviewed the criteria for determining cabin comfort in postwar transport airplanes. These criteria were determined experimentally by building a full-scale section of the DC-6 airplane cabin in a large thermal conditioning test chamber wherein temperatures ranging from the tropics to the stratosphere could be imposed on the exterior while the cabin was fully occupied by passengers. Here, comfort requirements were measured and charted in terms of humidity, temperature, air motion, pressure change, and other factors. A general comfort range varying from 68° to 83° temperature, and from 30 to 70 per cent humidity was established. It was found that the humidity range could be varied between 15 and 85 per cent, provided the temperature was approximately right.

By designing cabin pressures equivalent to 6,000–8,000 ft. for flights in the neighborhood of 25,000 ft., high pressure differentials can be avoided. Thus, in a DC-6 flying at 20,000 ft. with cabin altitude maintained at 7,000 ft., the differential pressure would be about 4.5 lbs.

Automatic controls were described whereby the cabin could be made to fly its own altitude course, while the airplane flies another. Requirements for maintaining comfort on the ground were discussed, and an air conditioning system was outlined which supplied cabin refrigeration or heating as needed.

In the discussion following the paper, Mr. Froesch pointed out that, while this was one more "gadget" for the airplane and would probably mean another maintenance unit in the shop, it was a vital piece of air-line equipment. The only alternative was to redesign the human ear and provide a booster pump for the heart—which did not appear practicable at present!

* Director of Aviation Research, The Brookings Institution.

J. Parker Van Zandt, Commentator.

Program Chairman, Charles Froesch.

The question was raised, since the circulating fans were electrically driven, whether a power connection on the ground, in place of an auxiliary airport truck, would not be enough. In reply, Mr. Del Mar pointed out that to handle ground refrigeration under summer conditions would require some 60 hp. If no auxiliary equipment were available, the two outboard engines could be run at approximately 1,200 r.p.m. to provide full cooling on the ground.

The second paper, dealing with the "Development of International Standards for Airworthiness of Transport Aircraft," was presented by Paul A. Puvrez, Expert of the Provisional International Civil Aviation Organiza-

tion (PICAO). The standards developed by the PICAO Airworthiness Division for scheduled passenger landplanes were compared with those presently enforced in the United Kingdom and in the United States.

Flight requirements on take-off were first considered in terms of the critical point, where, if the most critical engine failed, take-off can be safely continued or alternately abandoned. While PICAO standards are essentially the same as American requirements in this respect, they allow the designer maximum freedom with respect to flap setting and other factors.

PICAO and United States climb requirements are both based on formulas that express the rate of climb in terms of the stalling speed, whereas British requirements stipulate a minimum rate of climb of 3.5 per cent.

On controllability and stability, PICAO standards, again, more nearly approach those of the United States than the United Kingdom. In establishing structural load factors, PICAO requirements are based on the experience of its member states and allow considerably more flexibility than either U.S. or U.K. requirements. All three regulations, however, agree on a lower limit of 2.5 for the load factor at designed maneuvering speeds.

With regard to gust conditions, in the United States requirements are for gust intensities of about three-fifths those in the PICAO and British requirements. The American formulas, however, give greater load factors for a given gust intensity, so that the three sets of requirements yield, within a small per cent, about the same result. Since too little is known about the building up of gust, PICAO recommends further study of this problem.

Mr. Puvrez concluded by pointing out that the international standards adopted are more than a simple compromise between varying national standards. By reviewing the reasons that have led to different national criteria, it has been possible to base international standards on a broader foundation. The result has been a standard that yields more freedom to the designer without any sacrifice of safety. This is a starting point for new progress in airplane design.

The final paper of the morning session was presented by Jerome Lederer, Chief Engineer of Aero Insurance Underwriters, on "A Survey of Aircraft Rescue Requirements." Mr. Lederer pointed out that more lives are lost because of fire following crash than is generally realized. For example, adequate fire fighting facilities were brought into prompt use in only three of 17 fire-after-crash accidents studied; yet these three cases accounted for 40 per cent of the survivors of the 17 accidents.

Aircraft crashes were classified according to three types of rescue operation—namely, (1) delayed response but organized rescue, (2) prompt response but unorganized rescue, and (3) immediate response and organized rescue.

While the present estimate for transoceanic flights is only one ditching every 4 years or more, even for such a remote eventuality it is obvious that careful plans should be made. The history of ditching landplanes indicates the possibility and desirability of maintaining buoyancy when ditched, instead of having passengers resort to life rafts for survival.

Most modern air transports already have a good deal of inherent buoyancy, especially with empty fuel tanks. There is a case on record of a DC-3 having floated over 50 hours after ditching. Additional buoyancy might be maintained by flotation bags, since 1,000 cu.ft. of air will support 60,000 lbs. Designers must think of survival at sea in terms of continuous buoyancy of the airplane rather than depend on rafts or life vests for survival of the occupants.

Improved crew protection is a requirement of first importance. The better the crew is trained, the more important it is that they survive for the sake of the passengers. The idea that the pilot should be the first to suffer makes interesting literature but is contrary to passenger safety.

Designers and operators have great responsibility to assure the highest degree of fire protection when a crash occurs. British practice in this respect appears better than ours, since they have planned their fire extinguishers for use in crashes, as well as in flight. If crash occurs, an impact actuated switch automatically turns on the extinguishing liquid. Individual bottles are installed in each power egg. Batteries are also disconnected automatically by the impact switch so that broken connections may not set off a fire after impact.

Another challenge to the ingenuity of designers is the rapid evacuation of passengers in an emergency. If the nose wheel of a large aircraft were to collapse in a normal landing, allowing the tail to rise, the distance from the main door to the ground on some planes is equivalent in height to the third floor of a house.

There appears to be vast room for improvement in crew training for rescue operations. The investigation of one accident, for example, disclosed that the cabin attendant was uncertain as to the location of emergency exits and had not been trained to use them. If ditching in cold water is inevitable, survivors should have at their disposal some means for keeping warm for a minimum period consistent with the time that rescue would be expected to arrive. The problem then, is to estimate the probable length of time before rescue teams are likely to pick up survivors and arrange to keep them alive at least to that time. This applies to all isolated areas, the desert, the polar ice cap, and the tropics.

The greatest opportunity for saving lives is in connection with accidents on or near an airport. While economic considerations are the main deterrent to the establishment of ideal rescue operations, a great deal more can be done than is now typically the case. For example, an average of one out of 50 air transports can be expected to overshoot and crash off the end of runways each year. Barriers or traps similar in principle to those used on aircraft carriers would greatly increase the effectiveness of rescue operations, and their use is strongly commended.

In the last analysis, however, the airplane designer and the air-line operator must carry the main burden

for safety. This can be done by reducing the probability of injury to occupants, including the crew, by adopting every possible way to eliminate fire hazard; by training crews; and, of course, most important of all, by reducing accidents.

Following Mr. Lederer's paper, Otto E. Kirchner, Director of Aircraft Engineering, American Airlines, showed a company training film on evacuation techniques for DC-4 crews. Approved methods for evacuating 50 or more persons in 2 min. or less under various simulated conditions, such as nose-wheel collapse, were illustrated.

The afternoon meeting was a joint session with the Institute of Navigation. Joseph Lyman, Research Engineer for the Sperry Gyroscope Company, read a paper on "The Application of Microwaves to Instrument Landing of Airplanes." The development work described was conducted at a frequency of approximately 3,000 megacycles (10-cm. wave length). To increase the sharpness still further, a frequency as high as 5,000 megacycles can be used. In this case the antenna can be inclosed in a housing molded from dielectric material which can be buried in, say, the vertical stabilizer.

Another advantage of using microwave energy is that the entire tuned radio-frequency part of the circuit (coils, condensers, and wires) are built in as an integral part of the vacuum tube itself. Transmission of radio-frequency energy from one part of a system to another takes place in sealed hollow pipes or sealed coaxial transmission lines. Thus, almost the entire radio-frequency part of any microwave system can be sealed off from external disturbances. This in itself guarantees a higher order of reliability than has been common practice with low frequencies in the past.

The general requirements of a fixed-beam landing system are: (1) azimuthal guidance, (2) glide angle guidance, and (3) distance indication. Mr. Lyman's paper dealt in detail with the desired characteristics of the localizer and glide path to meet these first two requirements. The importance of a monitor was also stressed, to ensure reliable indication of beam position and stability. A monitor informs ground operating personnel that they have set up a correct path in space which is open for public use upon demand. Ideally, the aircraft operator should have the same monitor information available to him as to the ground operator.

As a result of development work to date, it appears that microwave radio technique offers a way to avoid many of the problems that have made progress difficult in the past. Eventually Mr. Lyman believes it will be possible to secure operational automatic control of aircraft in instrument landing up to and including the end of the landing roll.

In the discussion Mr. Froesch expressed his concern over the addition of still further auxiliary apparatus to the already complicated airplane. It is time, he said, to begin to think in terms of simplification rather than further complication. What about weight, the author was asked.

On this point Mr. Lyman was not prepared to commit himself. He did feel, however, that eventually it would be possible to reduce reserve fuel on long-range flights. Any equipment, he suggested, which permitted 100 per cent performance of the aircraft would justify itself economically as long as the added weight and complications were kept within reasonable limits.

The final paper of the joint afternoon session was a description of the "Teleran System of Air Navigation and Traffic Control," by L. F. Jones, Manager of Research and Development Projects for the Radio Corporation of America.

Essentially, Teleran employs a ground search radar that surveys the air space of interest and displays on a cathode-ray tube the information thus received. This radar presentation is viewed by a television camera, a map of the area is superimposed, and the combination picture is broadcast by a television transmitter. This picture is reproduced by a television receiver in the plane, and the pilot sees himself as a spot of light moving across a map. Other planes appear as different spots of light, each moving according to its actual course.

Since each pilot is primarily interested only in those aircraft at approximately his own altitude, a fnethod of separating radar echoes according to altitude is included in the Teleran system so that a separate picture for each altitude level is transmitted. The transponder in the plane which makes possible this altitude separation also serves to increase the range of the radar equipment, and, by use of a reply frequency different from that of the ground radar transmitter, confusing radar echoes from ground objects are eliminated.

This combination of radar and television techniques constitutes a system of great flexibility. It not only makes possible the transmission of ground radar information to aircraft but also provides a means of transmitting other data, such as weather maps, ceiling and visibility information, and traffic instructions. The pictorial presentation of all this information constitutes in itself an important forward step.

Teleran includes means for aircraft to complete instrument landings by picture, by "talk down," and fully automatically. In the pictorial approach, a vertical line representing an extension of the runway shows the pilot whether he is on course, and mileage marks along the line indicate distance to the airport. A horizontal line shows the plane's vertical position with respect to the correct glide path—that is, when the plane is at the correct altitude, the line passes through the pip.

While this type of presentation is similar to the well-known "crossed pointer" indication, it appears to have several important advantages. The distance information is continuously and automatically displayed; the indication for the glide path has the same sensing as an artificial horizon so that a natural presentation is produced. The pilot also sees the positions of other aircraft on the glide path and can therefore make his let-down with complete confidence.

The landing radar used to provide these data is the azimuth and elevation sector scan radars of the "G.C.A.," but the search radar of the latter system is not needed, nor are radar operators required.

Mr. Jones states that the introduction of Teleran could be accomplished gradually and economically. The installation of ground surveillance radars, landing radars, and air-borne beacons with distance and azimuth indicators would constitute the first transition step. Installation of television in the plane would constitute the final and most important step. Air-borne equipment would weigh from 90 to 125 lbs., including television receiver, air-borne beacon, radio altimeter, V.H.F. receiver, off-airway equipment (including distance meter, azimuth meter, and computer), and automatic flight control equipment.

In the discussion it was pointed out that the range of the system was limited only by the limitations of radar and that a 50-mile radius service area was considered a realistic and safe value to use in predicting radar coverage. In response to a question as to how many planes could be handled on a glide path at a time, Mr. Jones replied there virtually was no limit. For planes not equipped with beacons, a separate scope would be used either to talk the planes down or direct them elsewhere. Mr. Jones also stated that the equipment would be installed in a Link trainer this winter and would be flying before the end of 1947.

In the evening, a large and enthusiastic audience attended the joint dinner of the two institutes which was held in the attractive dining room of the Washington National Airport. Among the distinguished guests were the Chief of the Army Air Forces, Gen. "Tooey" Spaatz, and the inventor of British radar, Sir Robert Watson Watts. Also present were the crews of the Air Forces' "Pacusan Dreamboat" and the Navy's "Truculent Turtle."

S. Paul Johnston welcomed the gathering for the Institute of the Aeronautical Sciences and Gordon Atwater for the Institute of Navigation. Sherman M. Fairchild made the presentation of the Colonel Thomas L. Thurlow Navigation Award to Wing Comdr. K. C. Maclure, of the Royal Canadian Air Force, for his outstanding contribution to the science of navigation. Mr. Fairchild pointed out that the system of polar navigational flying developed by Commander Maclure was used by the navigator of the "Dreamboat" on his recent transarctic flight.

The principal speaker of the evening was Theodore P. Wright, Administrator of Civil Aeronautics and Past-President and Honorary Fellow of the Institute of the Aeronautical Sciences, who delivered the following address.

Aids to Air Navigation

Address by T. P. Wright at Washington, D.C., National Air Transport Meeting Dinner, Jointly Sponsored by I.A.S. and Institute of Navigation.

I feel sure that few, if any, will take exception to the statement that we in the United States now have the best airways system in the world and that we have more experience than any other nation in the development, establishment, maintenance, and operation of an airways system. One indication in substantiation is the fact that other nations, notably our neighbors Mexico and Canada as well as several other members of the British Commonwealth, have approved and adopted our system.

We intend to keep it the best through the same cooperation that created it. For although the Civil Aeronautics Administration is the Government Agency of primary responsibility, this system is the result not only of the work of C.A.A. engineers, pilots, and technicians but also of the ideas, development and research, and practical assistance so generously given by many others in industry and Government.

But because of this very collaboration, however, there has developed, at least among laymen, a certain confusion. More and more companies have entered the field of electronics, stimulated greatly by the feverish wartime activity. Each new company in the field is likely to mean several new air navigation aids offered for consideration. Therefore, understandably, the proud parents are prone to advocate their respective brain children as the ultimate solution to air navigation or traffic congestion problems. This causes confusion and as well prompts the layman to ask why these wonders of modern science are not put into immediate use by the C.A.A.

We must remember, however, that the C.A.A. is the servant, or agent, of the American people as a whole under its Congressional mandate "to foster and encourage civil aeronautics." And we are deeply conscious of that responsibility. We have the additional responsibility of spending public funds wisely.

Economy a Factor

We must, therefore, investigate thoroughly all proposed aids to air navigation; assist in the development of the most promising to the point where they are safe and economical for civil use; and, when we are reasonably sure of our ground, go to the Congress with recommendations for appropriations to be used in the federal investment in airways. Such funds involve millions of dollars for initial investment and more millions for subsequent operation and maintenance. Under these circumstances, it readily can be seen that, when the C.A.A. selects a device for installation on a national basis or recommends one for international standardization, it must be one that will serve effectively as well as efficiently long enough to justify the tremendous costs involved.

Congress, as is proper, scrutinizes our airways budget request very closely and in fact, because of mounting costs, has directed us to prepare a comprehensive study, including a possible system of charges that might be applied for the use of the airways. This makes it even more important that we develop our airways system so that the public, the ultimate users, will receive its money's worth.

Orderly Development

These are economic considerations, but of even greater importance are those of safety. As scientists you know that prolonged study is required to develop new devices to that point where the lives of the public can be entrusted to them. It generally is recog-

nized in this regard that a different standard applies to the military world, where calculated risks can be accepted, than would be warranted in civilian life. When the public is involved, both industry and Government must appraise new ideas on the scales of safety before their adoption. And here let me interpolate that appropriate and effective steps have been taken and are now in operation which assure coordination of development of air navigation aids. The organizational structure and procedures involve coordination of Government agencies and, as well, Government-industry cooperation.

The need for careful consideration of development projects, assessed from the standpoint of economy and safety does not mean, however, that we should be fearful or hesitant about experimenting with new ideas. The C.A.A. and its predecessor agencies have explored boldly many new paths. It intends to continue to do so. It pioneered the radio range, which was a revolutionary development essential to the transition from all contact to instrument flying; it developed the instrument landing system, recognized as a significant advance, although the war delayed its adoption for civil use for 5 years; and in 1943, when the word "radar" was unknown to most people, the C.A.A. instituted a program for improvement of our traffic control system by means of radar techniques, but unfortunately, here again wartime security considerations made possible but little progress.

Scientists are aware of the time it takes to perfect any radically new device. Patience is an essential element in the scientific make-up, and an attempt must be made to convey some concept of this to the general public. We must at the same time, however, guard against two dangers: One originates within our own ranks —the quest for perfection which withholds from public use an essentially sound device for "just one more little improvement"; and the other is insufficient development money—this is a matter for the Congress to decide—whether civil aviation research shall be kept on a starvation diet or be given the funds necessary to an all-out effort to apply wartime advances to civil use and to permit us to catch up with the time lost for purely civil aviation progress because of necessary concentration on the war effort.

History of Airways Development

The history of the development of the federal airways system abounds with examples of cooperation, of experimentation and of adaptation. I will cite a few instances.

The lighted airways is one. Congress in 1926 passed a civil aviation law that provided that existing agencies of Government were to be utilized. That law pointed directly to the Lighthouse Service of the Department of Commerce, and an employee of that agency, expert in optics and beacons, shared his knowledge with the new Aeronautics Branch as it stepped into a comparatively unknown field.

Parallel with that, a Post Office official made a suggestion. Paul Henderson, Assistant Postmaster General in charge of air mail, was standing on the platform of a railway station in the flat country of Kansas when he saw the light of the locomotive that was approaching. Misjudging its distance, he started walking toward the loading section when his friends told him that the train was many miles away and there was no need to hurry. The straightness of the track, the levelness of the terrain put the beam of light squarely into his eyes making it visible a long way off, and he began to realize its possibilities in guiding airmen. Pilots added their tests, and the revolving beacon was applied for air use. This 24-in. beacon for contact flight still is the backbone of the night airway, although we now have many that are 36 in. in diameter.

Marking airways in daytime depended at first only on visual aids. As a result, 54-ft. arrows at beacon sites marked airway direction pointing to the next beacon, while a program of other similar signs painted upon highways and rooftops was inaugurated. This type of navigational aid is still important to the private pilot, and great effort to extend the air marking system is currently under way.

These, however, in the main were fairly elementary aids. It was important that the rapidly evolving and developing technical opportunities afforded by radio be utilized in air transportation. In 1928, the Aeronautics Branch of the Department of Commerce made its first application of this new airway aid by the installation of radio ranges. The range, which consists essentially of a radio transmitter, alternately transmits two interlocking signal patterns keyed "A" and "N" in Morse code. Usually the four legs created by the intersection of the two signal patterns are so arranged that they form an "X" with the "N" in the north and south quadrants and the "A" in the east and west quadrants. When a pilot is directly on a range course, the two signals merge into a steady tone. Thus the pilot flying to the right of the range course, as required on the airways, hears a steady tone with an underlying "A" or "N," depending upon the quadrant in which he is flying. These four-course ranges are so arranged in relation to each other as to mark the route of the airways across the nation.

The range also transmits automatically, in Morse code, the letters that identify a particular station. As stated before, these ranges are limited to sending out signals along four legs. They operate in a low frequency band, therefore, reception is subject to static interference and the courses are subject to bends in mountain areas. The methods utilized to eliminate these deficiencies are described later.

At the same time, there was developed a system of very high frequency marker beacons to be used, in conjunction with the courses of the radio range, as "fixes." These are small transmitters sending up a signal that tells the pilot where he is along a range leg. Today we have approximately 250 of these in operation.

A program of construction of intermediate fields, in order to permit safe landings in event of emergency, was inaugurated. These, at first, were placed 30 miles apart and approximately 50 were constructed. As the interest in aviation developed, municipal fields appeared and these also were added to the intermediate landing area system. With the increasing speed of airplanes and the development of greater dependability of engines, it was found feasible to place such intermediate and emergency fields even farther apart. Of course, with the perfection of the National Airport Construction Program, the nation will be dotted with fields available for all types of aircraft, and these all can be utilized as intermediate fields, making possible a substantial reduction in the number of those necessary solely for airways emergency landing purposes. Incidentally, intermediate fields may and are in many cases open to general public use where so sponsored by a community.

While striving constantly for optimum provision for safety and general effectiveness of the Federal Airways, the factor of economy has always been kept in mind. An excellent example of this occurred in 1932. Until that time, the federal agency operating the airways system had leased the teletype machines that carried reports concerning conditions of airports, weather data, and other safety information. A large rental was paid for each teletype machine each month, and it was felt that this cost was exorbitant. A detailed study of these operations was made wherein it was shown that maintenance should not be more than a fraction of the rental cost for each machine if the Government owned the teletypes.

It was recommended that the then Aeronautical Branch of the Department of Commerce purchase the proper number of these machines amounting to a quarter of a million dollars, which at that time was a very sizable amount in Government expenditures. The result in saving since 1932 has proved the valuable economies that can be achieved through public ownership of the equipment needed in operating the airways.

These, very briefly, are some high points of the history of Federal Airways in this country. In its entirety it is a story of tremendous human interest, full of drama, humor, hard work, and the unselfish effort of men inspired by an ideal.

The Airways Today

Radio ranges and lights (the latter to a lesser extent, though still important to many users) still are the backbone of the airways today. Low-frequency ranges are spaced at about 200 miles along the 40,000 miles of aerial paths we maintain. The C.A.A. leases 138,000 miles of land lines for communications. It maintains 25 airway traffic control centers strategically placed about the country and operates some 125 airport traffic control towers.

We find ourselves today with congested airports. Under present instrument conditions using low-frequency equipment, our traffic controllers can bring in on one runway at most ten aircraft an hour. If that airport does not have a parallel runway for use in take-off, this figure may be still further lowered. This is not enough. The ideal, of course, is to approximate good visibility conditions during instrument weather and bring in 60 planes an hour safely. This still is not enough as we view the certain increase of scheduled flying. This, then, is possibly the major problem today. It is the subject of hard and continuous study and development by the C.A.A. and others. Many solutions are suggested, some practical and some fantastic. It is our task to select and apply the best, because ours also is the responsibility to see that there is no waste of funds.

Air traffic control affects airport design and size and cost. In times of congestion under instrument conditions, there are *today*, actually, only a few apparent solutions. We might restrict our major airports to scheduled air transport. That, in turn, might imply that the scheduled carriers ought to consider owning their own exclusive fields. We might designate several airports properly separated at big cities and assign incoming planes to spread the traffic. That would mean each air line would have to maintain service crews for planes and facilities for passengers at several terminals, an expensive procedure. Or, we might build our airports so big that we could use a comprehensive system of parallel or tangential runways. Still another solution would be the design of aircraft with landing and take-off characteristics so much improved that it would affect our whole traffic-handling problem. The problems are difficult and possibilities of corrective measures are many, but continued development and painstaking study will discover the proper solutions.

But one important device that will help answer the demand for a system of landing by instruments in bad weather is now ready for use at many locations. I refer to the C.A.A. instrument landing system mentioned heretofore. It has had wide acceptance in principle and will get substantial use in scheduled air transport this winter. The Provisional International Civil Aviation Organization Standards Committee, in its recommendations for standards and practices issued last November, recommended the adoption of the SCS-51 "or similar type of instrument landing system." (The SCS-51 developed during the war is the portable version of the C.A.A. system.)

The C.A.A. instrument landing system is no suddenly developed device. As far back as 1928, when aeronautical radio as a whole was relatively undeveloped, a series of studies were undertaken in the Department of Commerce by its Aeronautics Branch and the Bureau of Standards. As a result, a three-element system was originated which consisted of localizer radio beams thrown out in a vertical plane down the central line of the runway; a glide path plane at about $2^1/_2°$ to the horizontal which gives the pilot the correct angle of descent and which intersects the localizer to form a proper pathway in the air; and marker beacons which, by flashing lights on an instrument panel in front of the pilot, show the distances from the "touch-down" point. The process of flying the system is simplified for the pilot by the use of an instrument consisting of two pointer needles actuated by signals from the localizer and glide path beams showing him his relation to the "on-course" path. Supplementary aids associated with it are automatic direction finder stations and approach light lanes, the former as an aid in accuracy of flying approach procedures and the latter as a means for assuring early visual contact with the ground.

We expect to have approximately 52 of these instrument landing systems in operation by the first of the year, and the air lines are proceeding with their training of pilots and equipping of planes to use this aid to bad-weather landing. The C.A.A. is confident that this system will contribute substantially to safe handling of planes in instrument conditions and that, when the pilot's skill and technique have been developed, will make it possible in bad weather to land in the order of 30 planes per hour. In its final form, it is contemplated that the system will be hooked up with the autopilot, further increasing its effectiveness, thus making automatic instrument approach, and possibly eventually instrument landing, possible.

In addition to the instrument landing systems installed at civil airports, there are about 27 military installations that will be available for use by any pilot in an emergency. Thus, the airways will have more than 75 instrument landing systems available for use by the first of the year.

The air lines planned to have all of the scheduled transport planes equipped with instruments necessary to utilize this bad-weather flying aid by the first of the year. We understand that practically all air-line planes are already equipped with localizer and marker beacon receivers and that most are equipped with racks for the glide path receiver and with glide path receiver antennas.

Thus, all that remains to complete the installation of the airborne instrument landing equipment is the placing of the glide path receivers in their racks in the planes and connecting them to the instrument panel. It is my information that this equipment will be installed in most cases no later than January 1, so that the operation of the instrument landing system for use at points equipped, as mentioned above, will be an accomplished fact at that time. Then we will have made possible a substantial speeding up of the landing frequency under instrument conditions.

The Radio Technical Commission for Aeronautics recently conducted tests at New York using the localizer, marker beacons, and compass locator stations only. As a result of these tests we are confident that we can bring in a plane in safety every 3 or 4 min. This timing will be further improved possibly to 2- or 3-min. intervals when using the glide path in addition.

We are interested, also, though possibly to a lesser extent, in lowering the ceilings for scheduled air-line operation and thus improving frequency of schedules "made good." A reduction of ceiling minimums from 500 to 200 ft. (with commensurate reduction in visibility requirements) with equal safety is our first objective. This will contribute materially to schedule regularity as the number of unflyable days per year at most airports will be reduced from 6 or 7 per cent to 1 or 2 per cent.

We are going ahead on radar as rapidly as money, personnel, and equipment are available. The Army has agreed to lend us three of the newest G.C.A. (Ground Controlled Approach) radar systems, which we will install and operate at LaGuardia, Washington National, and Chicago airports. The war-developed G.C.A. required five or more operators with commensurately large operating cost if the system were to be generally applied to our civil airways. The manufacturer of the latest type hopes so to reduce requirements of operating personnel as to make wider application practicable. The C.A.A., however, would not be justified at present in proceeding more rapidly than the above program indicates until further service test this winter points more positively to the next appropriate step. It appreciates fully the advantages of G.C.A. as a supplemental aid.

Our policy is to test and develop methods and systems that are presented and which seem to have promise, introducing them into the Federal Airways system only as they are proved technically, money is available, and equipment can be procured.

An analogy, demonstrated time and time again in the field of aircraft development and production is relevant. Sound progress can only be attained by an evolutionary process—research, experimental development, service test and correction, and production. To jump a stage or to pass to a succeeding stage without consolidating the position in an earlier one usually spells disaster.

At the start of the war we had in production semiobsolete types of aircraft when viewed in terms of advances known to research workers or even when compared to experimental models. Yet we had to fight the first two or three years of war with these planes as they (or their production facilities) were "in being." Many attempts to jump a stage and put unservice-tested models into production proved disastrous. For one thing, this optimism caused "stop production" orders on existing models, unwarranted as future experience proved when repeatedly "resume production" orders of the older types were necessary accompanied, however, by costly lapses in output thereby. There were several instances of models that were "finally" taken out of production in 1941 or 1942 that were still "actually" in production and being effectively used, with improvements, in 1944 and 1945

Let us not through overoptimism as to "just over the horizon" developments in the electronic field jeopardize the substantial progress in air navigation and instrument landing available by the use of equipment now in being or in process of installation.

The whole subject of airways today is too big to handle comprehensively in a talk of this kind. Therefore permit me to give you briefly an enumeration of the services our airways render today to the flier, scheduled and nonscheduled.

Air Navigation.—(1) Radio ranges (L.F. and some V.H.F.), (2) monitoring services for radio ranges and markers, (3) homing stations, (4) intermediate field signaling service of all types not otherwise indicated herein, (5) operation of aeronautical lights, (6) operation of markers and special devices, and (7) direction finder service.

Traffic Control.—(1) Two-way communication with aircraft, (2) interphone and teletype services for traffic control, (3) airway traffic control, (4) airport traffic control, and (5) approach control.

Weather Information.—(1) Hourly and special weather reports and Notices to Airmen, (2) synoptic weather reports and forecasts for map-making information, (3) broadcasting of weather information, (4) overseas weather service, and (5) weather reporting service furnished by aircraft communicators.

Operational Information.—(1) Aircraft movement information, (2) advisory service to aid pilots by supplying helpful information, and (3) telephone services.

Airways Tomorrow

More interesting possibly is what our airways will be tomorrow.

Of great importance is the transition now under way from the low frequencies of our present range system to very high frequency. Started early in the war, here again installation was interrupted. We are going forward now with the equipping of nine complete airways with four-course aural-visual ranges in the 112–118 megacycle band. One has been in successful use since early last spring, and others are approaching completion. Chief advantage of these ranges is that they are substantially static free, thus they are available when most needed.

The development illustrates very well one of our problems, which will be understandable to anyone engaged in development work. Right in the midst of our changeover program (L.F. to V.H.F.), our engineers found an improvement. They had reached the point in their development of the omnidirectional range principle where the durability and practicability of its use instead of the four-course, aural-visual was indicated. This turned out well, however, because the change from one to the other proved to be relatively simple and inexpensive. As a result, all these V.H.F. ranges will be omnidirectional when the nationwide system is completed.

These V.H.F. omni ranges are for short-distance use, usually over the land. For long, overwater hops, a high-powered low-frequency omnidirectional range has been developed. It will also serve over desert and jungle areas, where it is not possible to build the many V.H.F. range sites required (one each 100 miles). War-developed Loran is the current standard for long-range overwater operations.

Also over the continental United States, we will have a long-range system. This will be for use by airplanes making long flights, usually on great circle courses, and at high altitudes. It will consist of 15 omnidirectional ranges, operating on low frequency and using about 40-kw. power. These 15, to be used as is any omnidirectional range, will cover the United States, parts of Canada and Mexico, and large coastal areas of both oceans by a "grid." A pilot can take bearings on at least two anywhere in the country, thus obtaining a fix.

The first is now being installed at Nantucket Island, Mass. Others will be at New Bern, N.C.; Miami, Fla.; New Orleans; Ft. Wayne, Ind.; Minneapolis; Tulsa, Okla.; Brownsville, Tex.; El Paso, Tex.; Cheyenne, Wyo.; Great Falls, Mont.; Salt Lake City; San Diego, Calif.; San Francisco; and Seattle.

Certainly in the future are several important developments in radar. That again is, in itself, a subject for a complete and comprehensive talk. We received $80,000 for radio and radar work in our last year's budget! This year we have about $180,000. For next year, we have asked for five times that much, all insignificant when compared to requirements as measured by funds expended for such purposes during the war. Our job, however, is to translate the remarkable achievements of the military in the use of radar during the war to civilian use, to make it practicable as a civilian airways aid.

Many other airway aids are under development at our Experimental Station at Indianapolis. I am sorry not to have time to discuss them in greater detail, but the mere mention of some will give you an idea of what is under development for our future airways.

Instrument landing probably is the most important, and we are continuing to develop the C.A.A. three-element system. One important improvement of the instrument landing system now under development and previously mentioned is the completion of work for automatic instrument landing through a hookup with the automatic pilot. We are doing this at Indianapolis; the Army is working along similar lines; and the Sperry Gyroscope Company is developing a system that contemplates doing the same thing but utilizing microwave frequencies. One of the interesting papers presented at today's technical sessions dealt with this system. These are promising developments which offer great hope for even safer, more frequent, and better executed landings in instrument weather.

Then there also is the Ground Controlled Approach, or G.C.A., instrument landing system. This is a most promising development, particularly as a supplemental and monitoring aid. As mentioned before, through courtesy of Army loan we will try out three at important terminals as an auxiliary aid this winter.

The radar scanning screen in an airport control tower is another. Our new, model tower at Indianapolis is equipped with such a screen and is in daily service test. Funds for additional units are in our 1948 budget request.

I have referred previously to the marker beacons and the radio ranges that provide "fixes" for the pilot. Today, we have under development a distance-measuring device that will tell the pilot his distance from a ground station and will make possible the removal of the marker beacons along the range courses, thus relieving us of the maintenance problem that the operation of these markers entails. This equipment in the plane will be light and inexpensive and will give the pilot a direct indication of his distance in miles from the beacon on the airport to which he is flying. Thus, through the use of this distance indicator in conjunction with the azimuth information provided by one omnidirectional range signal, he will be able continuously to establish a "fix" anywhere within receiving distance of the ground station.

An important feature of the C.A.A.'s present and future program concerns approach lights. At Indianapolis, we have an approach path lighted by six different systems, each using a different type of light. They are so arranged that they can be turned on one after another from the control tower as the test pilot makes his observations in flight. Approach lights are an important supplementary aid to the instrument landing system.

Tryouts on a service test basis at two locations (Chicago and Newark) using three separate systems are planned this winter.

In another project, we are studying individual lights of miscellaneous kinds and uses. One of these is a 30,000,000-c.p. light that emits flashes briefly and with such intensity that even in daylight and at long distance a pilot is guided to an airport. Another is a neon tube showing red on the inside and green on the outside to mark the boundary of an airport. Another system aims at an improvement over previous methods of marking the boundary of runways, and still another is an extension light for marking runway boundaries in deep snow.

We plan, then, on the use of V.H.F. omnidirectional ranges supplemented by the distance indicator for comparatively short flights on and off the airways; high-powered low-frequency omnidirectional ranges for long great circle high altitude flights; and C.A.A. instrument landing system supplemented by G.C.A.-Radar at large airport terminals; these we will supplement with other aids as they are developed and proved to be suitable. Search radar is planned for important traffic control towers.

At the present time, demonstrations are being made under the auspices of PICAO to determine international standards for air navigation facilities of the future. The demonstrations in the United Kingdom were completed in September, and those in this country have just been finished at Indianapolis. The devices mentioned above and many others advocated by companies have been explained and demonstrated.

Early next month representatives of all member countries will meet in Montreal to review the "state of the art" as demonstrated in existing facilities used in this country and abroad and, as well, to consider the possibilities for the future as shown in demonstrations of experimental devices either entirely new in character or as developed during the war for military uses. It is my confident belief that the Federal Airways system now in operation in the United States will receive favorable consideration from the nations of the world as including the basic systems for aids to air navigation, traffic control, and instrument landing which must prevail during the next several years. These should, and will be, supplemented by other devices as they have proved their worth. Important among these will be radar and television in combination. At this afternoon's technical sessions the RCA system known as "Teleran" was ably described as encompassing several features that approximate the ideal of converting instrument flying into contact for the pilot.

Conclusion

The C.A.A. assignment encompasses all phases of civil aviation. I have purposely confined this talk to the Federal Airways, because in this field there has been so much discussion in the press as to what we have done, might have done, or should now do in further perfecting the system.

In addition to the Federal Airways program, which forms some 80 per cent of our activities, we carry out as you know the requirements of the 1938 Act in the field of safety regulation, subdivided into activities pertaining to aircraft, airmen, and flight operations. In this field our philosophy is to delegate the maximum amount of authority and responsibility to individuals and industry, commensurate with maintaining a high degree of safety for the public. We point toward inspecting individuals and organizations rather than their end products.

Again, in the field of airports we have a large task, expanded to tremendous proportions by the passage last summer of the Federal Airport Act. In raising the total number of airports in the country from about 4,000 to about 6,000 and in improving many others, we hope to assure a foundation for aviation in the United States appropriately proportioned for the use of scheduled air transport, nonscheduled aviation, and for the personal owner.

We have other tasks to perform in the fields of education, in continuing the expansion and successful operation of the Washington National Airport, and in the expansion of our activities in the foreign and international field.

I have tried in this discussion to show you our position in the field of air navigation, indicating where we stand and where we are pointing in both short- and long-range aids, in air traffic control, and in instrument landing systems. Our objective is by electronic means to make it possible for the pilot under instrument weather conditions to fly with the ease and safety that he has in contact flying conditions.

I will close by re-emphasizing that we *do have a program* and that this program is *coordinated effectively* between the several Government agencies and private industry associations that deal with the subject. The program contemplates following sound development procedures with a view to providing optimum safety to the public, with accompanying ease and reliability of operation for the Air Transport operators and other users of the air space, all with appropriate consideration to economical use of public funds.

Plan to attend the
I.A.S. Honors Night Dinner and
Fifteenth Annual Meeting
in New York, N.Y., January 27–30, 1947

Current Problems in Developing Major Components for Aviation Gas Turbines

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ABSTRACT

Many problems remain to be solved before the present simple type of aviation gas turbine appears in its optimum form. The turboengine differs from the reciprocating engine in that basic problems are best solved generally on the individual major components rather than specifically on the complete engine. This type of approach enables the designer of a specific turbine engine to meet more nearly the requirements imposed by the type of installation for which the engine is intended. In this paper the functions and requirements of the various major components are presented, together with an evaluation of their present state of development and a listing of the most important current development problems that must be solved in each case.

INTRODUCTION

THE BASIC REQUIREMENTS of a successful engine for aircraft propulsion are so difficult to meet from a technical standpoint that the engineering effort required to develop such an engine is extremely great. The final cost of an aircraft propulsion engine, therefore, reflects to a much greater extent the cost of the engineering activities than does most other mechanical apparatus. Careful technical control and coordination of the engineering effort are consequently important.

In the reciprocating engine field, tremendous developmental efforts have been required to bring an engine from the original conception to service standards. It has been stated that five million dollars of engineering effort is required to successfully develop a reciprocating engine for aircraft propulsion. It is not expected that the engineering effort in the turbine engine will be appreciably less. However, in many ways the manner in which this effort is expended will be decidedly different.

The development of the reciprocating engine has been characterized by extensive engineering effort after the design of the basic engine is laid down. In the case of the turbine engine the principal engineering effort comes before the basic design, the reason being that the turbine engine is made up of a number of physically separate components that perform the various thermodynamic functions of the gas-turbine cycle. These major components are amenable to individual research and development before they are incorporated into a basic engine design. After detail design and manufacture of a specific engine, it is difficult to make any significant change to any of the major components without necessitating a major redesign. This is because of the mechanical and aerodynamic interdependence of the various components which are physically strung out in such a way that their structural design must be carefully coordinated.

The engineering job of creating a new service turbine engine may be broken down as follows:

(1) Fundamental component research coordinated with thermodynamic and application studies which lead to the decisions on the general design of the basic engine.

(2) Specific research, design, and development of the individual major components.

(3) Integrated detail design of the whole engine with particular attention to installation and contract requirements.

(4) Manufacture of prototypes.

(5) Development and proof testing of complete prototype.

(6) Redesign for production.

In the job of creating a new reciprocating engine the work done on development and proof testing of the complete prototype (listed as Item (5) above) has loomed large, and, to a great extent, has received the major effort. In the case of the turbine engine, which may be conveniently divided into separate major components, most of the development problems can be solved on the separate components before the engine is actually designed or manufactured.

Fig. 1 shows a high-speed compressor testing setup in which detailed development work may be performed on a full-scale compressor before its incorporation into a

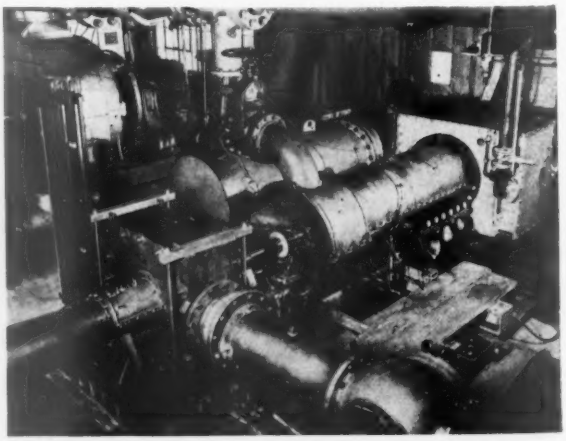

FIG. 1. High-speed compressor test setup.

Presented at the Annual Summer Meeting, I.A.S., Los Angeles, July 18–19, 1946.

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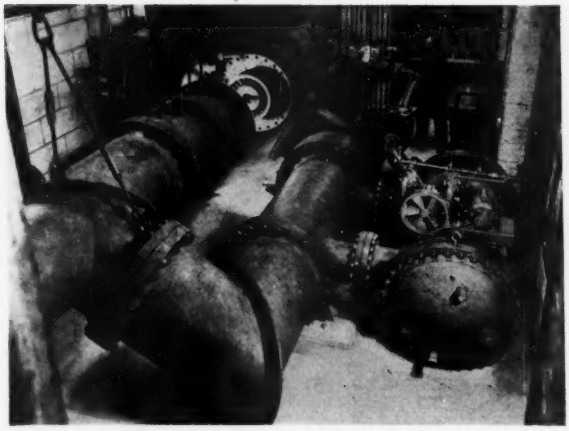

FIG. 2. High-density compressor and turbine test tunnel.

complete engine. A high-density wind tunnel, from which basic design information is obtained for both turbine and compressor, is shown in Fig. 2.

Even after a complete prototype engine is assembled, complete testing of the combustion chamber in the important high-altitude range must await flight tests or tests in an altitude wind tunnel. By testing the combustor alone in an altitude laboratory, combustor operating conditions equivalent to a wide range of altitude and flight speeds may be obtained even before the detail design of the prototype engine. Complete facilities for thorough tests of all the components of the aviation gas turbine are now available under one roof in the Westinghouse Aviation Gas Turbine Laboratory. Powers and air supplies large enough to test the components of any presently conceived gas turbine are available.

The work done on the separate components can be much more fundamental in nature and therefore may be applied to more than one engine. The discussions in this paper will deal with the first two steps in the creation of a new engine.

General Problems

The characteristics of a satisfactory aircraft propulsion engine are dependent on the application requirements. These requirements may be grouped as follows:

(1) Reliability.

(2) Performance, weight, and installation characteristics.

(3) Life and maintenance.

(4) Manufacturing simplicity.

The reliability of an engine may be defined as the degree of accuracy with which its mechanical performance may be predicted. Thus, if every engine of a particular design exploded at the end of just 10 hours of service it would be considered a reliable engine, though its life should be considered woefully short. The reliability of a service engine can be established only after many thousands of hours of experimental test stand and flight development running. Therefore, while the reliability of a service engine is of paramount importance, it will not be considered in this paper which deals with preprototype development.

The performance, weight, and installation characteristics of the engine are grouped together because they represent the most important technical characteristics needed in the performance evaluation of a complete aircraft. Life and maintenance with manufacturing simplicity of the engine are important in the economic and strategic considerations of the whole aircraft but need not be particularly considered in the technical aspects of the aircraft development.

The performance, of course, relates to the effectiveness with which the engine transforms the latent heat in the fuel into useful thrust on the air frame either through the jet reaction or the thrust of a propeller. What must be known is the maximum thrust that the engine will give under the expected conditions of forward speed and altitude under which the aircraft will operate, as well as the specific fuel consumption as a function of this maximum thrust and all lower thrust under these flight speed and altitude conditions. The transient conditions of engine operation, such as starting or changing thrust, are also important. The performance characteristics of an aviation gas turbine for a particular type installation may, by proper design of its components, be adjusted over a wide range to improve the performance under some operating conditions at the sacrifice of performance at other less important operating conditions. It is apparent that to be able to do this, a complete understanding of the operating characteristics of all the major components must be had, together with the knowledge of how to vary these characteristics by design differences.

The weight of an aircraft propulsion engine is of great importance. Although the weight of an engine is affected by the skill of the detail designer, it is largely determined by the basic engine design. Such variables as compressor and turbine diameters, number of stages and peripheral speeds, as well as combustor volume and configuration, all count in determining the weight of an engine. The type of installation may affect the weight of a design. For instance, stresses are usually critical at sea-level high power, high flight speed conditions. Therefore, two engines of similar aerodynamic design and power at altitude could be of considerably different weights if one is intended to operate at reduced load at sea level.

The installation characteristics of an engine are affected by such geometric considerations as diameters, volume, position of inlet and exhaust ducts, center of gravity and placement of support lugs, as well as gear and propeller locations. These installation characteristics are important, particularly those (such as frontal area) which are reflected in the external drag associated with the engine installation.

The life and maintenance characteristics of an aircraft propulsion engine are both important from a tactical and economic standpoint. The ease of maintenance of an engine depends greatly on the detail de-

sign of the engine, while the life of an engine is primarily a function of its basic design.

Manufacturing simplicity counts from economic and logistic standpoints. Although the manufacturing simplicity of an engine depends on the detail design of an engine, still it is necessary that the basic designer and developer pay particular attention to simplicity of concept and design.

The Major Components

The simplest gas turbine for aircraft propulsion, the turbojet engine, consists primarily of a compressor, combustion chamber, and turbine, as shown in Fig. 3. The addition following the turbine of an afterburning combustion chamber increases the thrust of the simple engine by increasing the available energy for expansion through the exhaust jet. If a reduction gear is placed at one end of the main shaft and low pressure stages are added to the turbine of the simple turbojet engine, a simple open-cycle propeller-drive gas turbine results. This is shown schematically in Fig. 4. The expansion in the turbine may be broken up into one or more groups of stages with reheat combustion chambers inserted. This usually increases the output of the turbine and, therefore, of the engine. The compression may be broken up into two or more parts with intercooling inserted. This should reduce the power required for compression and thereby increase the output of the engine. In addition to all this, a regenerator may be inserted to transfer heat from the exhaust gases issuing from the turbine to the cooler air coming from the compressor. This reduces the fuel required in the combustion chamber to bring the air up to the desired turbine inlet temperature, thus resulting in an increase in thermal efficiency. Therefore, the major components that will be considered are: the compressor, main combustion chamber, turbine, afterburning combustion chamber, main reduction gear, reheat combustion chamber, regenerator, and intercooler.

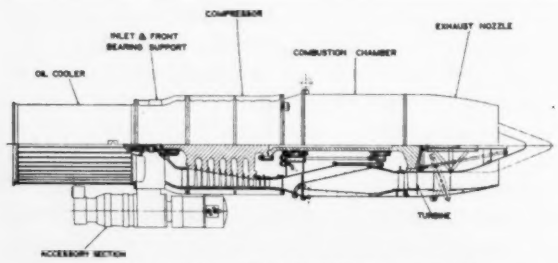

Fig. 3. 19-B turbojet (longitudinal section).

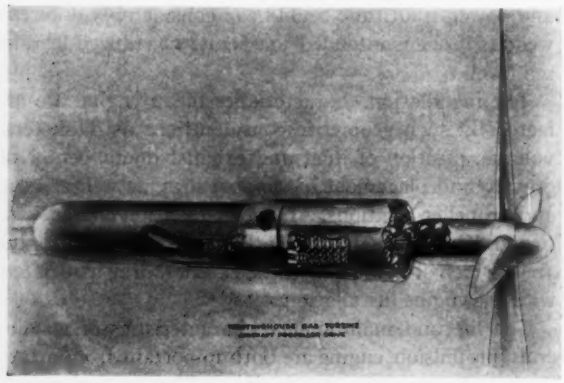

Fig. 4. Turboprop engine (schematic cutaway).

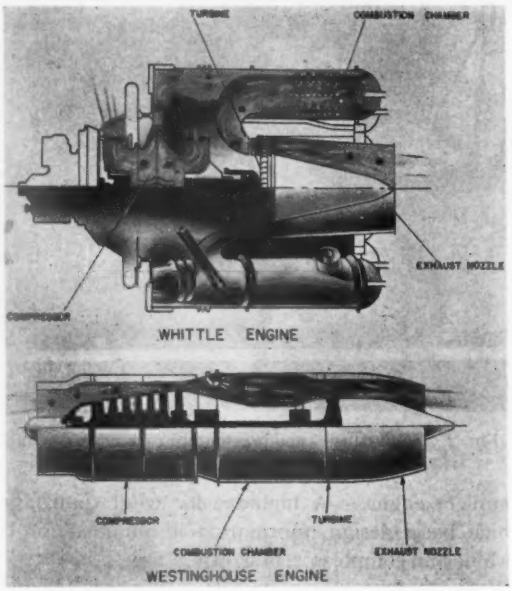

Fig. 5. Comparison of axial and centrifugal turbojet engines.

The Compressor

There have been many discussions about the relative advantage of the axial and centrifugal compressors. Both types undoubtedly have superior points. The Westinghouse Electric Corporation at the start of their aviation gas-turbine development selected the axial compressor on the basis of the high specific mass flow per unit area and the high efficiency. This compressor used in conjunction with the annular combustion chamber results in a long slender engine with admirable installation characteristics. The aviation gas turbine, because of the extremely high powers as well as the low specific weight it is capable of, appears most attractive as the propulsive means of a high-speed aircraft. If it is to be used for low-speed craft, efficiency is of great importance. The axial compressor engine appears equally attractive for either of these purposes. In high-speed craft, the great reduction in frontal area, and therefore drag, is illustrated by Fig. 5 in which axial and centrifugal jet engines of approximately the same power are compared. The McDonnell FD1 Phantom developed for the Navy as a carrier bomb fighter is an example of the clean installation of an axial compressor engine possible in wing fillets. The Navy's TD2N, a radio-controlled target drone developed by the Naval Air Materielle Unit (shown suspended under a Navy flying boat in Fig. 6) is an underfuselage installation of a $9^1/_2$-in. turbojet engine.

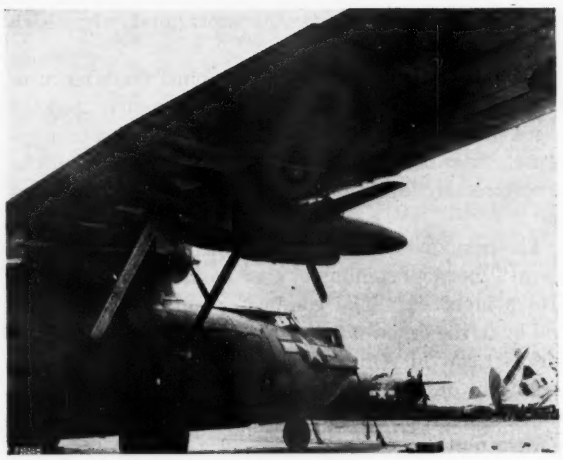

FIG. 6. TD2N (radio-controlled target drone) suspended under wing of Navy flying boat.

The compressor has long been considered the heart of the gas turbine. Because of this conviction, more development effort has been expended on this component than on any other. The simple subacoustic axial flow compressor has, in a short period of intense development, emerged as a highly efficient kinetic machine. Compressors may now be conservatively designed with stage efficiencies of 90 per cent. If future trends in aviation gas turbines point to extremely high efficiencies with less emphasis on cost, weight, size, etc., the axial compressor stage will probably be capable of reaching efficiencies of 94 per cent with no great change in the present development techniques.

The design of an axial flow compressor for aviation gas-turbine application consists of a series of compromises in which the aerodynamic performance at design condition must be balanced against performance at off-design conditions, while the whole aerodynamic performance is compromised by considerations of weight, stress, size, and manufacturing costs. In many past designs these compromises have been made arbitrarily on the basis of intuitive judgment. It is necessary that a large amount of design information be obtained about the present type of axial compressor so that the most effective design compromises may be made and so that overall characteristics may be predicted.

The Main Combustion Chamber

The first Westinghouse turbojet engine employed 24 cellular combustion chambers. However, at an early stage in the development of these engines the annular chamber developed at the Westinghouse Research Laboratories was adopted. This combustion chamber, which is shown in the engine in Fig. 3, has several fundamental advantages: it fits in admirably with the axial compressor and turbine, reducing ducting to a minimum; it utilizes the available space most efficiently by eliminating dead spaces between the cellular combustion chambers; and it permits the designer to establish a radial temperature at the inlet to the turbine such that the highly stressed portion of the rotating blades near the hub runs at a lower temperature than the less highly stressed portion nearer the blade tip. An early disadvantage was the large air supplies necessary for development testing of this type. However, this disadvantage has been overcome. An exploded view of this engine, revealing the annular combustion chamber liner, is shown in Fig. 7.

The main combustion chamber of the aviation gas turbine has been developed to a point that was not considered possible a decade ago in view of the then prevailing furnace design practice. Heat release rates in the combustion zone of 8×10^6 B.t.u. per hour per atmosphere per cu.ft. are common today. Satisfactory operation for a simple turbojet engine is possible from engine idling at low flight speed and 45,000-ft. altitude to maximum power and high flight speed at sea level. For the combustion chamber this may represent a variation in combustion chamber inlet air pressure from one-quarter to over five atmospheres and a 25-to-one variation in heat release. Combustion chamber life has now reached several hundred hours.

At present, a remarkably small amount of fundamental understanding of the aviation gas-turbine combustion chamber exists. However, successful combustion chambers have been designed and during the development of these chambers a number of empirical solutions to specific problems have been evolved. Combustion chambers are usually made of sheet metal and are easy to modify. The great improvements in combustion chambers over the past several years have to a large extent resulted from careful testing under conditions simulating engine operation coupled with empirical modification. This method will probably continue to be the most effective tool of the combustion chamber developer for some time to come. However, the trend will undoubtedly be toward obtaining a better fundamental understanding of the combustion process through careful analytical work and research programs that will finally allow the synthesis of greatly superior chambers.

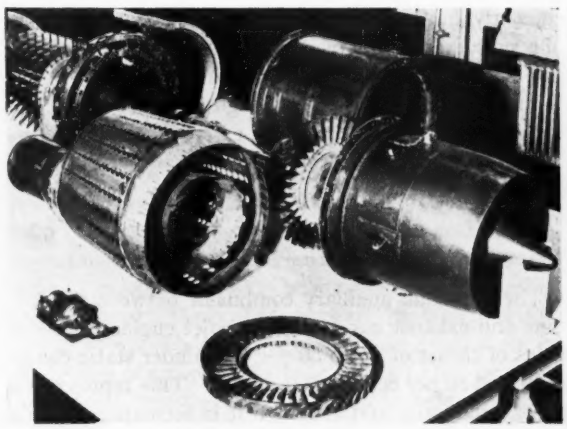

FIG. 7. Exploded view of 19B turbojet engine.

Future development studies will be aimed at reducing the size of the combustion chamber, which is now the limiting component of the engine from the standpoint of cross-sectional area. At the same time, pressure drop must be held at a minimum without sacrificing efficiency, particularly at altitude.

The Turbine

Substantially all aviation gas turbines built today embody an axial flow turbine designed by some type of vortex method with from 0 to 50 per cent reaction at the mean diameter. The basic aerodynamic efficiency (neglecting leakage of flow due to running clearances) is high. Ninety three per cent is not unusual. Further aerodynamic refinements may be expected to increase this figure by as much as 3 per cent. The attainment of these high efficiency levels is not likely to be reached in production engines in view of manufacturing tolerances and the build-up of dirt which will always prevent the attainment of the optimum blade profile. The term "no leakage efficiency" is misleading. The current turbine engine operates under such a wide variety of steady-state and transient temperature conditions that standard practice has allowed large running clearance in the turbine. The leakage losses this clearance induces may reduce the actual efficiency five to twelve percentage points below the no-leakage efficiency. The larger figure, unfortunately, will more generally apply to high pressure ratio turbines, such as are used in propeller drives, where high turbine efficiency is of paramount importance. Reducing turbine leakage losses to a minimum is a "must" and will necessitate close cooperation between the mechanical designer and the aerodynamicist to solve one of the most pressing present-day gas turbine problems.

The major development problem in the aviation gas turbine of today is forced by the thermodynamic advantages of going to higher turbine inlet temperatures. This is particularly true in the case of the gas-turbine propeller drive and, to a somewhat lesser extent, in the turbojet engine.

Operation at appreciably higher temperatures involves, even in addition to all the metallurgical gains currently foreseeable, some means of cooling the turbine nozzles, rotating blades, and discs to permit operation with turbine inlet temperature considerably above the metal temperature. Although liquid (water) cooling appears to be attractive, early practical success in this country, as was the case in Germany, will probably be with air cooling.

The Afterburning Combustor

The use of an auxiliary combustor between the turbine and exhaust nozzle of a turbojet engine results in gains of thrust of up to 50 per cent under static conditions and 80 per cent at 600 m.p.h. This represents a substantial gain, and although it is accompanied by a large increase in specific fuel consumption, afterburning would normally only be used for short bursts where high power is needed.

From a basic combustion standpoint, the afterburning combustor has a fundamental advantage in that the gases entering it are usually above the ignition temperature. This is counteracted to a certain extent by the lower pressure levels found in the afterburning combustor.

The principal development problems associated with the afterburning combustor arise from the high temperatures involved. The combustor outlet temperature will be in the order of 3,000°F. while the inlet temperature is 1,200°F. Obtaining the proper combustor wall cooling in order to promote combustor life becomes a major difficulty. The problems of flame stability also merit attention.

The Main Reduction Gear

There are many arguments between the proponents of the pure turbojet engine and the propeller-drive gas turbine. For the highest speed applications the turbojet will naturally be used. At high speeds (over 600 m.p.h.) the overall efficiency of the turbojet engine is just as good as the propeller-drive turbine, and the elimination of main reduction gear and propeller has reduced the specific weight of the power plant to half. However, from the overall standpoint, the propeller has much to recommend it, because of its definite advantages in take-off, climb, and cruising economy.

The reduction gear is a natural part of a propeller-drive gas turbine where for optimum performance the turbine speed must be many times that of the propeller. Kinetic speed reducers, because of their inherent low efficiency, will probably not take the place of the gear.

Much basic development work has been done during the past 15 years on high-duty reduction gears. This work has indicated the importance of extremely careful design as well as manufacture to insure uniform distribution of the load so that high duty may be realized without excessive local stresses. The main reduction gear can be made today to weigh less than one-twentieth of a pound per horsepower for a ten-to-one reduction in speed and a 95 per cent efficiency. Future development of the reduction gear will be directed toward still further weight reduction.

The Reheat Combustor

The use of the reheat combustor is an attractive way to increase the power of the turbine and, therefore, the output of a propeller-drive engine. An added advantage is the relative improvement of part-load cruising economy due to the smaller engine that can be employed to do a given job. The reheat combustor, which is thermodynamically akin to the afterburner, has most of the problems associated with this type but it has a considerably less severe life problem because of the relatively lower outlet temperatures. The necessity for the use of the reheat combustor will make itself felt as more

propeller-drive gas turbines are developed and lower specific weight with good port load performance are demanded.

The Regenerator

The regenerator is a gas-to-gas heat exchanger used to recover part of the heat of the gases leaving the turbine. This heat is added to the air issuing from the compressor, thereby reducing the heat that must be added by the combustion chamber through the burning of fuel. The regenerator looms important in most considerations of the gas turbine for land application. To date, the regenerator has not been used successfully in aviation gas turbines.

The regenerator gives the thermodynamic cycle advantage of a lower fuel heat addition in the combustion chamber. This reduces the fuel burned per pound of air. To counteract this advantage there is less available energy for expansion since the expansion pressure ratio is reduced by the product of the pressure ratios of both sides of the regenerator.

As the output of a mechanical power turbine is the difference between the turbine power and the compressor power, it may be seen that the available expansion energy level cannot be reduced greatly without actually having a lower thermal efficiency in spite of regenerator. This is particularly true in the case of cruising conditions when pressure levels are lower but velocities, particularly on the high pressure side, are much higher.

From all other considerations the use of the regenerator is unfavorable. Reliability is poorer because of a more complicated engine. The engine power per pound of air is reduced. The engine weight per pound of air is increased because of the added weight of the regenerator. The maintenance cost may be increased appreciably if the cleaning of the regenerator becomes difficult and frequent. All these factors have so far limited the use of the regenerator in aviation gas turbines.

A considerable development effort calling for great ingenuity will be required to bring the regenerator to a point where it is worth using in any but the longest range installations.

In addition to the important problem of creating a heat exchanger of high effectiveness and low pressure drop in a small light package, the problems associated with the deposits of low heat conductivity material from the products of combustion may not have a practicable solution.

The Intercooler

The use of the intercooler is intended to reduce the mechanical work required for compression by causing the entire compression process to approach somewhat the isothermal.

Usually an excess of cold atmospheric air is circulated through an air-to-air heat exchanger and removes heat from the air that is being compressed. Although the intercooler adds bulk and weight to the engine even when carefully designed, a small amount of additional thrust may be obtained from the cooling air by the well-known ram-jet principle, or at least the cooling air need not add a drag.

The intercooler has one fundamental advantage over the regenerator in that the addition of the intercooler tends to increase the output power of the cycle as well as the efficiency. Another advantage is that products of combustion need not be handled.

The intercooler problems are largely akin to those of the regenerator. These are to have low pressure drops on each side as well as small volumes and light weights. Fortunately, the intercooler, like the regenerator, need not be used in an aviation gas turbine until its development has reached a point were its inclusion is justified by practical considerations.

The Development Approach

The development of successful aviation gas turbines must be based on a careful approach to the problems involved, and the solution to these problems must be such that, even when the problems are clearly specific to a particular engine, the solution is general and may be applied successfully later. Only through a building-up of general solutions to these development problems can each engine developed be superior to its predecessor and the art truly move forward.

The development approach consists of, first, a great deal of careful analytical work. Often high-grade analytical studies reveal problems that ordinarily would not be discovered until months or even years later if an ordinary cut-and-try experimental approach were used. The experimental phase of solving a development problem should not be entered into until the analytical thinking is exhausted. At that time the experimental work should do two things, namely: (1) prove or disprove the analytically derived theory, and (2) obtain numerical coefficients to apply to the analytical solution of the problem. Experimental work will always reveal problems that need solving and it is foolish economy to wait for your testing to find out what these are. The third phase in the development approach is to record the solution of a problem in a general enough way so that it may be of use later. Every engineer knows the worth of writing an adequate report on a job, not only for later use, but to clarify the thinking involved in arriving at conclusions.

Synthesis of Engine Performance

Since the beginning of time, men have argued about the way to do things. These arguments have invariably been caused by ignorance rather than knowledge. Fortunately, in engineering, as contrasted with some of the other arts and sciences, disagreements on the most basic concepts are almost always resolved by the inexorable laws of nature. Many of the outstanding technical differences of opinion which existed in the past, such as over the use of direct or alternating current for distribution systems, steam engines, or steam turbines for large

(*Continued on page 91*)

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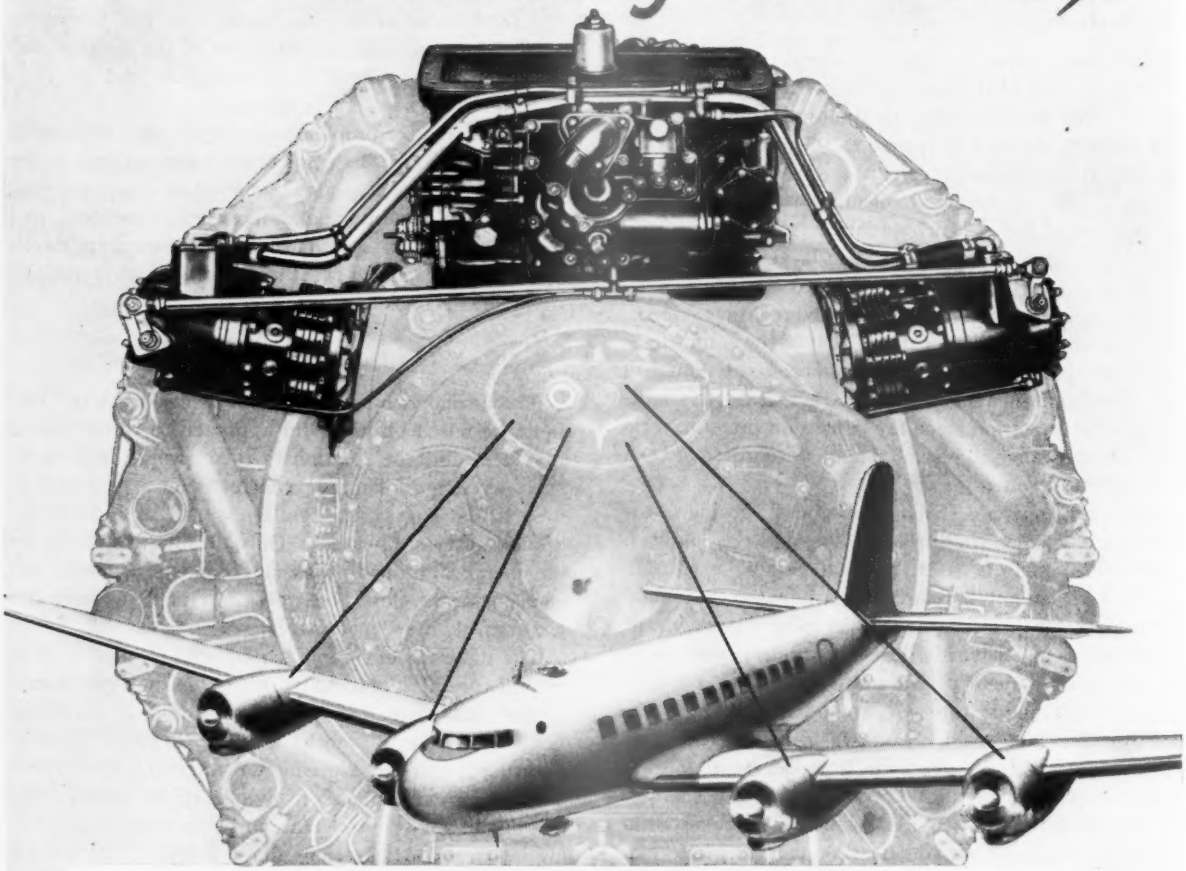

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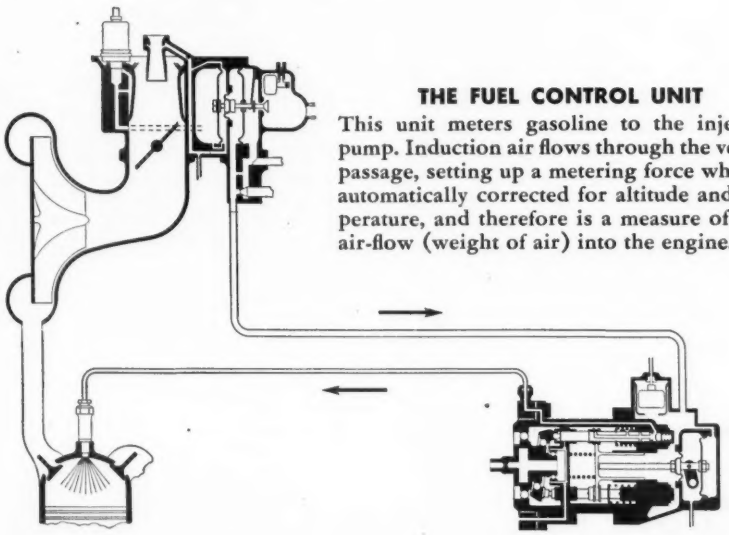

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This trend to more treads in airplane design stems from the outstanding safety and economy record made by the big twin-equipped ships during the war. Commercial aviation had its ear to the runway and heard the report: if one tire went flat, its mate held the plane safely on its course . . . and wheels were protected from damage, adding to both safety and economy.

B. F. Goodrich has advocated the use of twins for fifteen years. Development of twin tire landing gear assemblies is welcomed by engineers everywhere as still another step toward air safety. *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

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FIRST IN RUBBER

Aeronautical Reviews

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Aerodynamics

Additional Developments of Greene's Equation to the Study of Compressible Airflow. George L. Shue. Extension of Greene's "Attenuation Method for Compressible Flow Systems" to include the supercritical region leads to an empiric interpretation of supercritical conditions. The correction that is then applied to the airfoil incompressible pressure coefficient predicts supercritical flow conditions on the downstream side of the peak negative incompressible pressure coefficient. The calculated position of the shock that accompanies the return to subsonic conditions is shown to progress downstream with increasing Mach Number. With a suitable choice of a polytropic flow process the calculated chordwise pressure distribution checks with high-speed test data and this automatically brings the lift and pitching moment values into agreement with test results. The energy loss in the shock yields a reasonable means for calculating the increase in drag at high speeds. Each surface of the airfoil and each item in the airplane configuration are treated separately in estimating the drag. *Journal of the Aeronautical Sciences*, November, 1946, Vol. 13, No. 11, pages 581–586, 10 illus.

Tests on Elbows of a Special Design. John J. Harper. This paper presents the results of a series of tests on rectangular elbows of the type proposed by Szczeniowski. Six elbows were tested, including one conventional guide vane elbow designed in accordance with the recommendations in *R. & M. No 1773*. Four of the special elbows had an aspect ratio (A.R.) of 0.67, while the fifth had an A.R. of 1.5. The results disclose that under certain design conditions the special elbows show fewer losses than do conventional elbows with guide vanes. Increasing the aspect ratio of the elbow reduces the losses. *Journal of the Aeronautical Sciences*, November, 1946, Vol. 13, No. 11, pages 587–592, 17 illus.

Methods for Determination and Computation of Flow Patterns of a Compressible Fluid. Stefan Bergman. A well-known method of generating stream functions of an incompressible fluid flow is that of taking the imaginary part of an analytic function of a complex variable. In previous publications of the writer this method was generalized to the case of subsonic flows of a compressible fluid. Flow patterns, which until the present have proved impossible to obtain by existing methods, were, however, obtained by this procedure; for example, flows around an obstacle the boundary of which is a closed curve, as well as around nonsymmetric profiles. The procedure can be extended to the case of partially supersonic flows. As this method for obtaining flow patterns of compressible fluid from analytic functions of a compressible fluid requires rather lengthy computations, the present paper is devoted to a detailed discussion of performing these computations. The operations are divided into two groups: namely, those that need only be carried out once and can then be tabulated (or put on master cards), and those that have to be repeated in every individual case. A detailed description is illustrated by an example.

In the appendixes some theoretic questions, which to a certain extent complete the results of N.A.C.A. T.N. No. 972, are considered. For instance, in Appendix II, some questions arising in connection with the determination of flow patterns around a nonsymmetric profile and the use of linear integral equations for constructing flow patterns are discussed.

In Appendix III are indicated the alterations that are necessary in order that the operator which has been introduced for subsonic flows may be transformed into an operator generating stream functions of supersonic flows from two functions of one real variable. *National Advisory Committee for Aeronautics, T.N. No. 1018*, September, 1946.

Flow Over a Slender Body of Revolution at Supersonic Velocities. Robert T. Jones and Kenneth Margolis. The theory of small disturbances is applied to the calculation of the pressure distribution and drag of a closed body of revolution traveling at supersonic speeds. It is shown that toward the rear of the body the shape of the pressure distribution is similar to that for subsonic flow. For fineness ratios between 10 and 15 the theoretic wave drag is of the same order as probable values of the frictional drag. *National Advisory Committee for Aeronautics, T.N. No. 1081*, August, 1946.

On Laminar and Turbulent Friction (Translation of "Ueber Laminare und Turbulent Reibung," from *Zeitschrift für Angewandte Mathematik und Me-*

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chanik, Vol. 1, No. 4, August, 1921). Th. von Kármán. The theoretic treatment of surface friction of liquids or gases at a solid wall encounters serious difficulties as soon as the processes are no longer defined by the viscosity of the fluid alone but also involve the forces of inertia with the probable exception of the flow phenomena in capillaries and the problems of lubricant friction, as is the case in nearly all practical problems. However, two substantial advances have been achieved in this domain within the last decades—namely, by Prandtl's boundary-layer theory and Blasius' confirmation of the previously suspected nature of the friction loss in smooth pipes.

Unfortunately, the results of Prandtl's theory have remained confined to a comparatively narrow range; first, for the more obvious reason that the paper work involved for specific cases is enormous, and also because its physical range of validity is, like the theory of pure friction flow in pipes, restricted to narrow limits. Just as the pure friction flow, the so-called laminar flow in pipes, is replaced by a "turbulent flow" at higher velocities, so the laminar boundary layer is replaced by a "turbulent" boundary layer.

The present report deals, first, with the theory of the laminar friction flow, where the basic concepts of Prandtl's boundary-layer theory are represented from mathematical and physical points of view, and a method is indicated by means of which even more complicated cases can be treated with simple mathematical means, at least approximately. An attempt is also made to secure a basis for the computation of the turbulent friction by means of formulas through which the empiric laws of the turbulent pipe resistance can be applied to other problems on friction drag. *National Advisory Committee for Aeronautics, T.M. No. 1092*, September, 1946.

Wind-Tunnel Investigation of the Horizontal Motion of a Wing near the Ground (Report No. 437 of the Central Aero-Hydrodynamical Institute, Moscow, 1939). Y. M. Serebrisky and S. A. Biachuev. By the method of images the horizontal steady motion of a wing at small heights above the ground was investigated in the wind tunnel. A rectangular wing with Clark Y-H profile was tested with and without flaps. The distance from the trailing edge of the wing to the ground was varied within stipulated limits. Measurements were made of the lift, the drag, the pitching moment, and the pressure distribution at one section. For a wing without flaps and one with flaps a considerable decrease in the lift force and a drop in the drag were obtained at angles of attack below stalling. The flow separation near the ground occurs at smaller angles of attack than is the case for a great height above the ground. At horizontal steady flight, for practical values of the height above the ground, the maximum lift coefficient for the wing without flaps changes little, but markedly decreases for the wing with flaps. Analysis of these phenomena involves the investigation of the pressure distribution. The pressure distribution curves showed that the changes occurring near the ground are not equivalent to a change in the angle of attack. At the lower surface of the section a strong increase in the pressures is observed. The pressure changes on the upper surface at angles of attack below stalling are insignificant and lead mainly to an increase in the unfavorable pressure gradient, resulting in the earlier occurrence of separation. For a wing with flaps at large angles of attack, for distances from the trailing edge of the flap to the ground less than 0.5 chord, the flow between the wing and the ground is so greatly retarded that the pressure coefficient at the lower surface of the section is near its limiting value, and any further possibility of increase in the pressure is extremely small. In the application an approximate computation procedure is given of the change of certain aerodynamic characteristics for horizontal steady flight near the ground. *National Advisory Committee for Aeronautics, T.M. No. 1095*, September, 1946.

The Grumman Mallard amphibian. **(See page 45.)**

Two-Dimensional Wind-Tunnel Investigation of Sealed 0.22-Airfoil-Chord Internally Balanced Ailerons of Different Contour on an NACA 65_{112}-213 Airfoil. Albert L. Braslow. A two-dimensional wind-tunnel investigation was made of two interchangeable sealed 0.22-airfoil-chord internally balanced ailerons on an NACA 65_{112}-213 airfoil. One of the ailerons tested was of true airfoil contour and the other was modified by partly eliminating the cusp near the trailing edge. Tests were made to determine the effects of the aileron-contour modification on the section aerodynamic characteristics of the airfoil and aileron.

The results of the investigation indicated that the modification to the aileron contour caused the aileron effectiveness to increase slightly at low aileron deflections and to decrease slightly at large aileron deflections; caused the rate of change of aileron section hinge-moment coefficient with both section angle of attack and aileron deflection to increase positively; caused little change in the hinge-moment parameter for a given rate of roll at the low aileron deflections, but an increase in the hinge-moment parameter for a given rate of roll at the high aileron deflections; caused no appreciable change in the section drag coefficient, rate of change of section lift coefficient with section angle of attack, and airfoil critical Mach Number; and caused an increase of approximately 9 per cent in the maximum section lift coefficient of the airfoil with the ailerons neutral. The application of standard roughness to the leading edge of the airfoil increased positively the rate of change of aileron section hinge-moment coefficient with both section angle of attack and aileron deflection; decreased the aileron effectiveness throughout the aileron deflection range; and caused a smaller change in the hinge-moment parameter for the true-contour aileron at any given rate of roll than for the modified aileron. Aileron deflections of $-3°$ and $3°$ were found to have no significant effect on the airfoil critical Mach Number at the design section lift coefficient. *National Advisory Committee for Aeronautics, T.N. No. 1099*, July, 1946.

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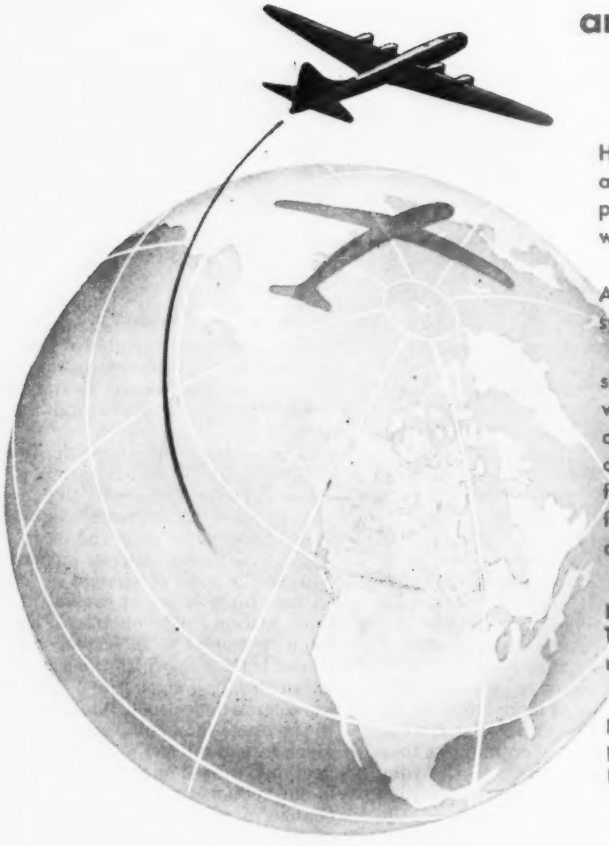

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Experimental Determination of the Effects of Directional Stability and Rotary Damping in Yaw on Lateral Stability and Control Characteristics. Hubert M. Drake. The effects of large variations of the directional-stability derivative (rate of change in yawing-moment coefficient with angle of sideslip) and the rotary-damping-in-yaw derivative (rate of change of yawing-moment coefficient with yawing-angular-velocity factor) on the lateral stability and control characteristics of a free-flying model have been determined by flight tests in the Langley free-flight tunnel. The effects of each parameter were investigated for three values of the lateral-force derivative (rate of change of lateral-force coefficient with angle of sideslip). In the tests the ailerons were used as the principal lateral control.

Increasing the rotary-damping-in-yaw derivative for medium or large values of directional stability and lateral force was found to improve the stability but to have little effect on control and general flight behavior. At low values of directional stability for low and moderate values of lateral force, moderate increases in the rotary-damping-in-yaw derivative slightly improved the control and flight behavior but larger increases caused the control, and hence the flight behavior, to become worse.

Increasing directional-stability derivative was found to be beneficial to stability and control in all tests. The value of directional-stability derivative required to obtain satisfactory flight depended to some extent on the accompanying value of lateral force; larger values of directional stability were required to obtain good flights with large values of lateral force than with small values. *National Advisory Committee for Aeronautics, T.N. No. 1104,* July, 1946.

The Influence of the Jet of a Propulsion Unit on Nearby Wings (Translation of "Der Einfluss eines Triebwerkstrahles auf einen in Nähe Befindlichen Flügel," *Deutsche Luftfahrtforschung, Untersuchungenund Mitteilungen,* No. 3200). H. Falk. The present investigation was intended to ascertain how far a tail unit is subject to disturbances by the jet of a propulsion unit. The parameters upon which this disturbing influence depends, and the values it reaches, are determined. *National Advisory Committee for Aeronautics, T.M. No. 1104,* September, 1946.

Thin Oblique Airfoils at Supersonic Speed. Robert T. Jones. The well-known methods of thin-airfoil theory are extended to oblique or swept-back airfoils of finite aspect ratio moving at supersonic speeds. The cases considered thus far are symmetric airfoils at zero lift having plan forms bounded by straight lines. Because of the conical form of the elementary flow fields, the results are comparable in simplicity to the results of the two-dimensional thin-airfoil theory for subsonic speeds.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

In the case of untapered airfoils swept back behind the Mach cone, the pressure distribution at the center section is similar to that given by the Ackeret theory for a straight airfoil. With increasing distance from the center section the distribution approaches the form given by the subsonic-flow theory. The pressure drag is concentrated chiefly at the center section and for long wings a slight negative drag may appear on outboard sections. *National Advisory Committee for Aeronautics, T.N. No. 1107,* September, 1946.

Flow Investigation with the Aid of the Ultramicroscope (Translation of "Stromungsuntersuchung mit dem Ultramikroskop," *Forschung auf dem Gebiete des Ingenieurwesens,* Vol. 8, Part 1, January-February, 1937). G. Vogelpohl and D. Mannesmann. On the basis of photographic pictures the laminar flow at a pipe inlet was measured and compared with other measurements and computational results. The test setup is described in detail and a series of the pictures obtained for turbulent flow is shown. *National Advisory Committee for Aeronautics, T.M. No. 1109,* October, 1946.

Two-Dimensional Wind-Tunnel Investigation of an Approximately 14-Percent-Thick NACA 66-Series-Type Airfoil Section with a Double Slotted Flap. Albert L. Braslow and Laurence K. Loftin, Jr. A two-dimensional wind-tunnel investigation was made for the purpose of developing a suitable double-slotted flap on an approximately 14-per-cent-thick modified NACA 66-series-type airfoil section. Section aerodynamic characteristics of the airfoil with various double-slotted flap arrangements are presented.

A maximum section lift coefficient of 3.0 was obtained for a 55° deflection of a flap arrangement employing a 0.0854-airfoil-chord vane (vane 4). The lift coefficients obtained for flap configurations with vane 4 generally were higher than those obtained with the other vanes tested and were less sensitive to changes in vane position and deflection. Standard airfoil leading-edge roughness caused approximately the same decrement in maximum section lift coefficient for the airfoil with the flap deflected 50° as for the airfoil with the flap retracted. Different values of the maximum section lift coefficient were obtained at high flap deflections when the angle of attack at which the test was begun was not sufficiently low to prevent initial airflow separation. *National Advisory Committee for Aeronautics, T.N. No. 1110,* August, 1946.

A Further Investigation of Lateral Stability. E. Priestley. Although lateral stability at high wing loadings is treated in *R. & M. No. 1840* and a general outline of the problem of its estimation is given there, that report does not include sufficient data to enable more than a rough estimation of lateral stability to be made for a particular aircraft. In Part I of the present report, lateral stability diagrams are given for a range of values of the lift coefficient from 0.1 to 1.0, of the relative density coefficient from 20 to 100, and of the rolling and yawing radiuses of gyration from 25 to 50 per cent of the wing semispan. The diagrams show the spiral and oscillatory stability boundary curves based on generalized values of given derivatives. Additional diagrams are given whereby these derivatives may be more accurately determined if required. The effects of changes of certain derivatives on the boundary curves are investigated.

In connection with asymmetric motions of the aircraft, the positions of the oscillatory and spiral stability boundaries have been determined: these boundaries separate stable from unstable regions on the diagram and enable it to be said (in theory, at least) whether a given motion will be stable or unstable. Part II of the report was written with the further object of determining the trends of the periods and dampings of these motions with such parameters as wing loading and height. Typical values of periods and dampings also are considered. The effects of changes in inertia coefficients are briefly considered. The appendix gives approximate methods of determining the period and damping of the lateral oscillations. *British Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1973.* British Information Services, New York, $2.25.

Blockage Corrections in a Closed Rectangular Tunnel. Part I: Simple, Approximate Formulae for General Application. A. D. Young and H. B. Squire. **Part II: Note on the Blockage Correction for Streamline Bodies of Revolution.** A. D. Young. This report embodies the two reports *A.R.C. 7328* (R.A.E. Technical Note No. Aero 1286, Misc.) and *7119* (R.A.E. Technical Note No. Aero 1258, H.S.T.). In Part I it is shown that for an elongated body of revolution of any shape in a closed rectangular tunnel of any cross section between square and duplex, the blockage correction is given by a formula involving the volume of the body and the length of the sides of the tunnel. For

a wing of any section spanning the tunnel a similar formula is based on the length of the sides of the tunnel, the area of the wing section, and the volume of the wing. These formulas are accurate to within about ±5 per cent. Another formula covers both cases and therefore the intermediate cases of a complete aircraft model having a span less than or equal to the width of the tunnel. That formula is estimated to be accurate to within ±10 per cent, which is sufficient for most cases. The formulas do not include wake blockage effects.

In Part II an approximate method for obtaining the source distribution of a body of revolution is used to derive the equivalent doublet whose field is the same as that of the body at large distances from it. The blockage correction factor was then obtained by Lock's method of replacing the image system for the body in a tunnel by a system of equivalent doublets. A value is found for the blockage correction factor for streamline shapes with pointed tails within range of the stipulated fineness ratio. A discussion of the accuracy of the method is given. *British Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1984.* British Information Services, New York, $0.75.

Sweepback, the Key to High-Speed Flight. D. R. Newman and J. C. Wimpenny. A brief account of the aerodynamic theory of swept-back wings and the attendant practical problems of design explains the subject in semitechnical language. The writers outline the basic theory by comparing the airflow and the local velocities and forces affecting a wing section held in a wind tunnel at right angles to the air stream with the conditions prevailing when the wing is held in a yawed position, showing that the yawed wing shock-stalls at a higher Mach Number than the unyawed wing, and that large gains in critical Mach Number may be expected for angles of yaw of 30° or more. The application of the theory is then discussed with regard to general stability and control; longitudinal stability; stalling characteristics; longitudinal and lateral control; directional and lateral stability; maximum lift; and structural aspects. It is concluded that the use of sweepback is justified by the ability to fly at high Mach Numbers, despite the disadvantages of tip stall necessitating the fitting of tip slots or some other cure; the limited increase of maximum lift due to flaps and slots; and the influence of flexural deflection upon control, longitudinal stability, and flutter. *de Havilland Gazette*, August, 1946, No. 34, pages 6, 7, 8 illus.

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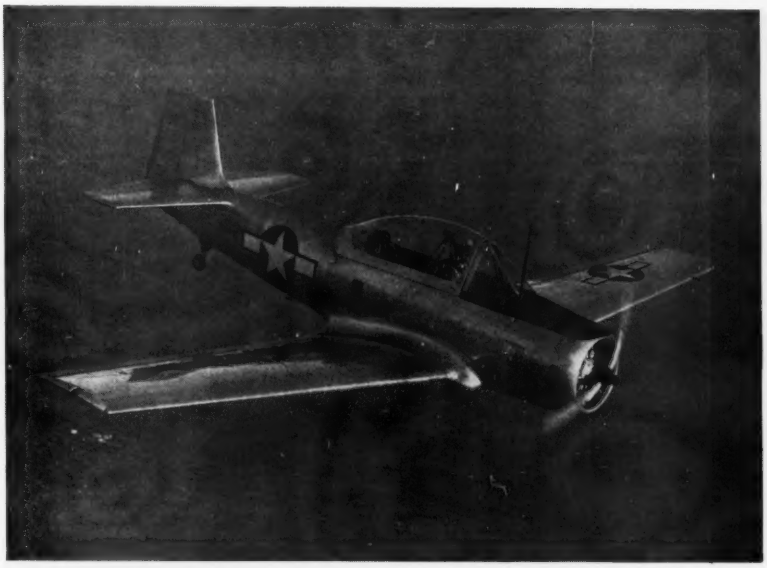
Air Transport, General

The Status of Civil Aviation in 1946. Henry Self. The Second British Commonwealth and Empire Lecture delivered before The Royal Aeronautical Society surveys the status of civil aviation, first, within the United Kingdom, then within the British Commonwealth and, finally, within the field of international civil aviation. Commencing with the governmental administration of the national effort, the writer gives consideration to the governmental approach to international administration of world aviation; the problems of ground organization within the United Kingdom, the Commonwealth and Empire, and elsewhere; and the creation and operation of technical services essential for air transport. Other questions dealt with are the problems of operational research and their possibilities for civil aviation; aircraft research, development and production; the financial picture; the past development and future prospects of world and regional air lines; and the psychologic reaction of the people to the air age. The closing section forecasts the place of civil aviation in a new world order of peacetime air transport. *The Journal of The Royal Aeronautical Society*, October, 1946, Vol. 50, No. 430, pages 719–784, 7 illus.

Air Travel Factors. A. Jaworski. Statistical methods are presented by which estimates may be made of the factors affecting air-transport operations. Sources of revenue, potential passenger and cargo traffic, costs, rates, and other variables are evaluated, and mathematical formulas are

suggested for forecasting the volume of traffic and the trends that have a bearing upon the success of the business of air transport. *Aero Digest*, October, 1946, Vol. 53, No. 4, pages 42–44, 3 illus.

Passenger Air Transport: The Problems of Aircraft Size, Frequency, Speed, and Passenger Accommodation. J. W. S. Brancker. Various problems of air transport are discussed in a paper read before the (British) Institute of Transport. Factors determining the size of the aircraft to be used for a particular service are considered. The frequency of service, which is closely allied to speed and must be determined by the traffic to be handled, also is discussed. With regard to speed, it is stated that fundamentally this is the one advantage that air transport can offer over other means of transport, and it must be exploited to its full extent. The problem of the type of accommodation to provide for passengers, which is dependent on aircraft size, frequency of operations, and speed, also is considered. *The Journal of the Institute of Transport*, August-September, 1946, Vol. 22, No. 8, pages 340–346.



The Fairchild XNQ-1 Navy primary trainer is equipped with flaps, electrically retractable landing gear, and a controllable-pitch propeller. The bubble canopy gives vision range for both instructor and student. (See "Fairchild XNQ-1 Navy Trainer.")

Airplane Descriptions

Civil Sea Otter. Particulars are given about the conversion of the Vickers-Supermarine Sea Otter for civil uses. The whole front-end arrangement of the aircraft remains largely unchanged but a door has been placed behind the copilot's folding seat to separate completely the cockpit from the main cabin. With all service equipment removed from the hull, a large space is made available for seating. Details are supplied about the seating arrangement, window layout, and the soundproofing of the cabin. Important specifications are tabulated. *Flight*, October 10, 1946, Vol. 50, No. 1972, pages 383–385, 4 illus.

A New Aeroplane for the Private Owner. Fokker's first postwar airplane—the F.25 Promoter—designed for the business man, is similar in construction to the Fokker GI, being designed with twin tail booms. Except for the tail unit and fuselage, which are built up of light alloy, the airplane is of practically all-wood construction. The low cantilever wing is in one unit and consists of two spars with plywood former ribs. The ailerons for lateral control and landing flaps are also of wood, to facilitate easy and inexpensive repairs. A feature of the fuselage is the large door, which may be jettisoned, and broad step which enables passengers to get in and out of the cabin with ease. The pilot is seated on a horizontally adjustable chair on the left and behind him there is a comfortable lounge seat accommodating three passengers. The engine, a 190-hp. Lycoming 0-435, or a 185-hp. Continental, is mounted on a tubular steel structure in the rear part of the fuselage and is separated from the passengers by a bulkhead fire wall with fireproof covering. The retractable tricycle-type undercarriage is hydraulically operated. Important specifications of the aircraft are listed. *The Aeroplane*, October 11, 1946, Vol. 71, No. 1846, pages 426, 427, 3 illus.

Japanese Interceptor Planes. The Japanese Shindin, a pusher-type interceptor aircraft now being evaluated by Technical Intelligence, Air Matériel Command, Wright Field, is reported to be the only one of its kind remaining. The construction of the aircraft indicates a concern for the safety of the pilot which contrasts with the lack of such provision in most Japanese planes that saw combat. The Shindin has self-sealing fuel tanks, 16-mm. armor plate forward of the cockpit section, 70-mm.-thick bullet-proof windshield and, for safety in bailing out, a charge to blow the propeller from the shaft.

The Henschel-type wing shows the German influence, which utilized unusually thick skin for strength. The wing is held together by large and widely spaced rivets. The cockpit is an integral unit of double-shell construction designed for quick removal of the outer shell for accessibility to the equipment. For armament the Shindin has four 30-mm. aircraft cannon, each holding 60 rounds.

The Ha Model 42 (18-cylinder Kinsei, MK9D) Mitsubishi engine has direct fuel injection. A unique method of oil cooling uses all the exhaust gases to force great amounts of air through the cooling system. The two-stage supercharger gives the Shindin a service ceiling of 39,000 ft. and an absolute ceiling of 42,000 ft. The small wheels on the lower tips of each vertical fin were added because the plane had a tendency to "squat" during take-off and landing. The anti-shimmy device installed on the nose-wheel strut is a direct copy from the American A-20. *Army Air Forces, Air Matériel Command.*

Fairchild XNQ-1 Navy Trainer. The Fairchild XNQ-1, a new Navy trainer, is a low-wing, all-metal, two-place monoplane with tandem seating arrangement. It is powered by a Lycoming nine-cylinder engine rated at 320 hp., the installation of which utilizes a new and improved power-package principle developed by Fairchild's power plant division. The airplane is equipped with flaps and has an electrically operated retractable landing gear. It is reported to be the first primary trainer equipped with a Hamilton Standard controllable-pitch propeller. Another feature of the XNQ-1 is the functional cockpit design which the Bureau of Aeronautics sponsored in order to provide a standard for all of its carrier-based aircraft. The cockpit is enclosed by an unobstructed one-piece bubble canopy, offering all-round vision range for both the instructor and student.

The XNQ-1 has a gross weight of 3,700 lbs. Its rate of climb is expected to be more than 1,000 ft. per min. and its maximum speed is estimated at 170 m.p.h. The wing span is 41 ft. 5 in.; overall length, 27 ft. 11 in.; and its height, 9 ft. 10 in. *Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation.*

Grumman Mallard Amphibian. The Mallard is a new luxurious-type 8–10-passenger amphibian built for scheduled air transport, for corporation executives' use, and for the private owner. Because of its size and equipment, it qualifies for conventional airline use, and because it is amphibious it can also operate in remote regions inaccessible to land-based airplanes.

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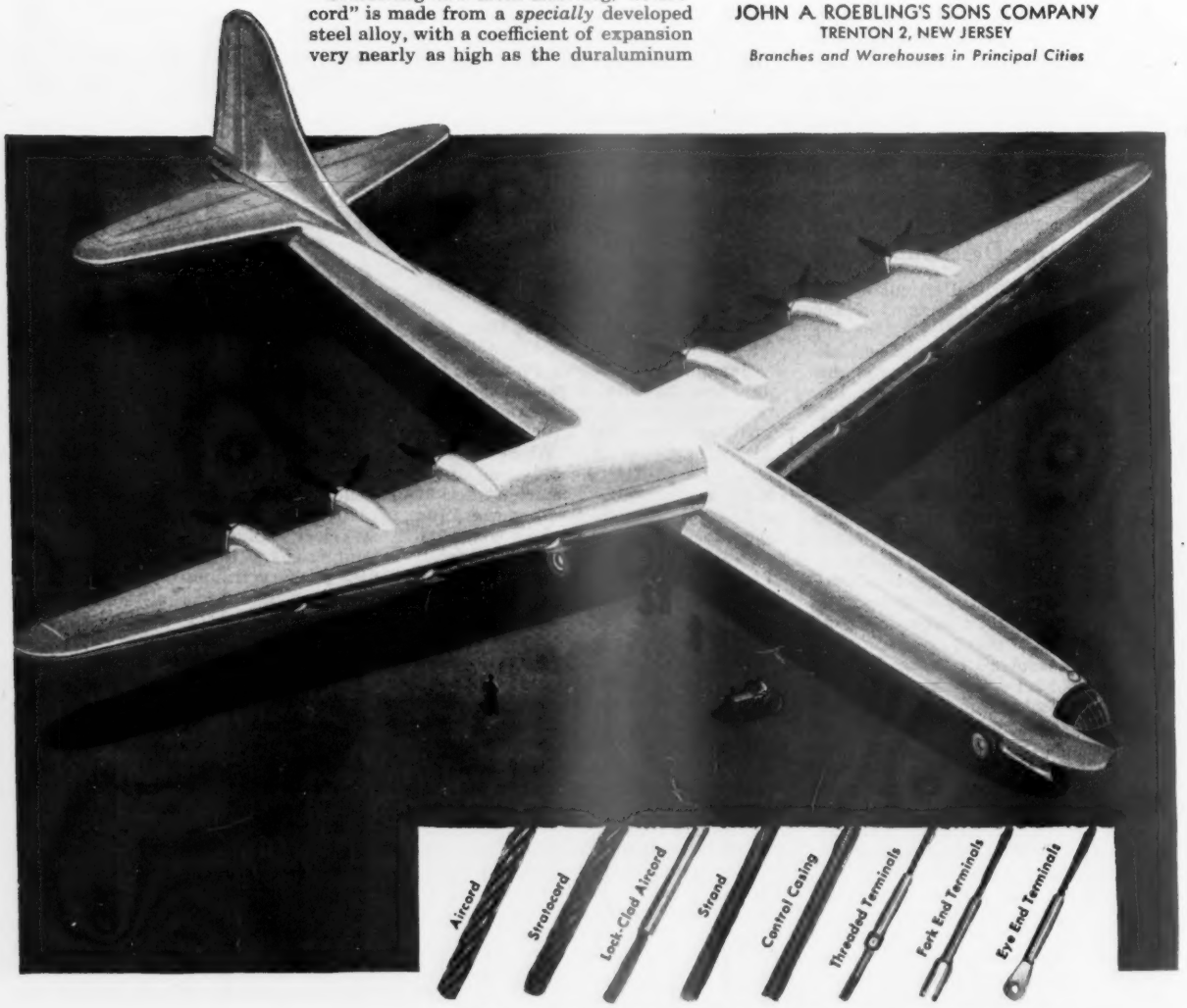

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The Mallard hull was designed to provide seaworthiness with minimum spray in rough water and minimum drag in a calm. The deep flare in the hull bottom permits smooth water landings and quick take-offs. The tricycle landing gear facilitates cross-wind and night landing on the ground. The interior is completely upholstered, carpeted, and soundproofed. It is ventilated by a thermostatically controlled heating and ventilating system with individually controlled fresh-air ducts. The Janitrol Whirling Flame heater is standard equipment.

The plane is powered by two Pratt & Whitney "H" Wasp engines of 600 hp. each, equipped with two Hamilton Standard Hydromatic full-feathering propellers. The craft's top speed is over 200 m.p.h. and it has a range of over 1,000 miles. In the event of an engine failure during take-off, the plane can proceed on one engine and clear a 50-ft. obstacle, or come to a complete stop on a comparatively small field. It is also rated with a single-engined ceiling of approximately 10,000 ft. Overall dimensions are wing span, 66 ft. 8 in.; wing area, 444 sq.ft.; length, 48 ft. 4 in.; and height, 19 ft. 4 in. The gross weight is 12,500 lbs. Its useful load as a transport is 3,280 lbs.

The Mallard is equipped with numerous safety devices, including dual brake systems, dual hydraulic pumps, with an auxiliary hand pump for emergencies, and engine fire extinguishers with an automatic fire detector that gives a warning in the cockpit and automatically places extinguishers in operation. *Grumman Aircraft Engineering Corporation.*

New British Aircraft. Brief information has been released concerning a number of new British airplanes now in the course of development and expected to be completed and tested in the near future. One of these is the Short Sealand amphibian, designed for feeder-line services, charter operations, and private transportation for company executives. Powered by two de Havilland Gipsy 71 engines of 330 hp. each, it will attain a speed of 190 m.p.h. at maximum power at 6,000 ft. Its cruising speed is 180 m.p.h. The range at this speed, with five passengers and baggage, will be about 450 miles. The rate of climb at full-load weight of 8,500 lbs. will be 920 ft. per min. at sea level and 780 ft. per min. at 10,000 ft. The service ceiling will be 21,500 ft. with both engines, and 8,000 ft. on one engine. Landing speed will be about 65 m.p.h.

Four prototypes are being built of the Heston artillery-observation plane. The design provides for a tail carried on twin booms and a de Havilland Gipsy Queen 33 engine installed just aft of the cabin and driving a pusher propeller. Normal gross weight will be 3,500 lbs.; overall length, 34 ft.; overall height, 9 ft.; wing span, 44 ft.; and gross wing area, 274 sq.ft. A tricycle landing gear is fitted.

A third new British aircraft is a trainer for the R.A.F., powered by a turbine-driven propeller, stated to be the first British application of the "turboprop" for a trainer airplane. The craft is a low-wing, cantilever monoplane of all-metal construction. Its span is 39 ft. 4 in.; length, 34 ft. 4 in.; height, 11 ft. 10 in.; and span, with wings folded, 21 ft. It is built by Boulton Paul Aircraft Ltd. and is powered by an Armstrong Siddeley Mamba turbine-propeller unit. The plane is designed for day or night instruction in gunnery, navigation, bombing, or glider towing, and is also adaptable for deck landings. *The Society of British Aircraft Constructors Ltd.*

Airplane Design

Comfort Can Be Compatible with Design Efficiency. William Lawrence Lewis. The writer suggests an approach to the problems involved in the development of a more advanced and satisfactory personal plane. He first takes up neglected factors of passenger comfort and utility and then considers means of improving aerodynamic and structural efficiencies. The design of a hypothetic aircraft devised as a result of the analysis is outlined and its theoretic performance characteristics are tabulated. *Aviation,* October, 1946, Vol. 45, No. 10, pages 55–59, 145, 8 illus.

The Airspeed Ambassador Takes Shape. A design analysis reveals the technical features of the Airspeed A.S. 57 Ambassador, a medium-sized British transport plane now nearing completion. The design of the aircraft was conceived so as to take advantage of the higher cruising speed offered by purity of aerodynamic form coupled with smoothness of finish, and the most outstanding design feature contributing toward its high economical speed is the large-span, low-drag wing with a thickness/span ratio of 21:2. In addition, one of the new laminar-flow wing sections has been chosen. Particular attention is given to details of airfoil and fuselage design and the layout of the control equipment, sketches being provided to clarify the discussion. Charts show the estimated performance of the transport, which is powered by two Centaurus 130 engines with two-speed superchargers. *The Aeroplane,* October 11, 1946, Vol. 71, No. 1846, pages 416–420, 14 illus.

More Airplane for Your Money. T. A. Wells. Consideration is given to the features that the personal plane should possess in order to provide utility. The items are taken up in the order in which the prospective owner would be confronted with them while on a cross-country trip. Features that will provide comfort and safety are discussed and performance requirements are outlined. *Southern Flight,* October, 1946, Vol. 26, No. 4, pages 20, 21, 1 illus.

NACA-Industry Conference on Personal-Aircraft Research. The technical papers presented at a conference on personal-aircraft design organized by the National Advisory Committee for Aeronautics and held at Langley Memorial Laboratory on September 20, 1946, have been compiled in a staple-bound book of 127 pages with additional pages of illustrations. The papers were presented by N.A.C.A. staff members and are classified according to general subject matter. Each classification contains from one to four papers, complete with illustrations, references, and notations. The classifications are as follows: flying qualities; stability and control; safety and spinning; wing design; propellers; drag cleanup; aircraft loads; seaplanes; power plants; and new research. *National Advisory Committee for Aeronautics, Langley Memorial Aeronautical Laboratory,* September 20, 1946.

Tank Tests to Determine the Effect of Varying Design Parameters of Planing-Tail Hulls: Part II—Effect of Varying Depth of Step, Angle of Afterbody Keel, Length of Afterbody Chine, and Gross Load. John R. Dawson, Robert McKann, and Elizabeth S. Hay. The second part of a series of tests made in Langley tank No. 2 to determine the effect of varying design parameters of planing-tail hulls is presented. Results are given to show the effects on resistance characteristics of varying angle of afterbody keel, depth of step, and length of afterbody chine. The effect of varying the gross load is shown for one configuration. The resistance characteristics of planing-tail hulls are compared with those of a conventional flying-boat hull. The forces on the forebody and afterbody of one configuration are compared with the forces on a conventional hull.

Increasing the angle of afterbody keel had small effect on hump resistance and no effect on high-speed resistance, but increased free-to-trim resistance at intermediate speeds. Increasing the depth of step increased hump resistance, had little effect on high-speed resistance, and increased free-to-trim resistance at intermediate speeds. Omitting the chines on the forward 25 per cent of the afterbody had no appreciable effect on resistance Omitting 70 per cent of the chine length had almost no effect on maximum resistance but broadened the hump and increased spray around the afterbody.

Load-resistance ratio at the hump decreased more rapidly with increasing load coefficient for the planing-tail hull than for the representative conventional hull, although the load-resistance ratio at the hump was greater for the planing-tail hull than for the conventional hull throughout the range of loads tested. At speeds higher than hump speed, load-resistance ratio for the planing-tail hull was a maximum at a particular gross load

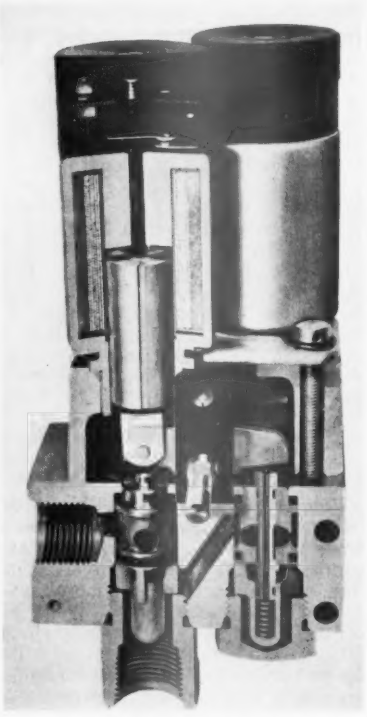
and was slightly less at heavier and lighter gross loads.

The planing-tail hull was found to have lower resistance than the conventional hull at both the hump and at high speeds, but at intermediate speeds there was little difference. The lower hump resistance of the planing-tail hull was attributed to the ability of the afterbody to carry a greater percentage of the total load while maintaining a higher value of load-resistance ratio. *National Advisory Committee for Aeronautics, T.N. No. 1101*, July, 1946.

Flight and Propulsion Spectrum. A chart illustrating the factors of flight and propulsion for the past and the probable future, prepared by the El Segundo Engineering Department of Douglas Aircraft Company, Inc., has been revised and reissued as visualized in the year 1946, to serve as a ready reference and to illustrate pictorially the principal factors involved in the development of flight. At the left-hand side of the chart, the origin and development of various aircraft and means of propulsion are illustrated, including such early ideas as those of Leonardo da Vinci, Hero, and the Montgolfier brothers; the inventions of the Wright brothers, reciprocating engines, turbojet engines, and rockets.

At the top of the chart are curves showing some of the most significant characteristics of high-speed flight pertaining to air-borne machines. These curves do not apply to rocket or space machines operating beyond the atmosphere of the earth. The first curve shows that present knowledge limits propeller-driven airplanes to speeds not exceeding 600 m.p.h. The second curve illustrates that a body flying through the atmosphere at increasing speeds for sustained periods of time will experience an increase in temperature due to friction or aerodynamic heating. Although this temperature would increase as the square of the speed, it has not been extended beyond 200°F. or 1,000 m.p.h. The third curve illustrates the abrupt increase in power requirements at speeds above 500 m.p.h. with present aircraft. The dotted line illustrates a probable power requirement that may be realized in the not too distant future as the result of intensive aerodynamic development. The curves are plotted in m.p.h. and Mach Numbers on a modified logarithmic scale.

Another part of the chart depicts the speed ranges of various types of missiles and aircraft, from the velocity of a meteor downward to the speeds of present-day airplanes, helicopters, dirigibles, and balloons. The bottom of the chart shows reproductions of a conventional airfoil for subsonic speeds, a present high-speed airfoil, and a probable supersonic airfoil shape. *Douglas Airview*, August-September, 1946, Vol. 13, No. 7, pages 12, 13.



Photograph Courtesy Adel Precision Products Corporation

Solenoid-operated selector valve incorporating rocker arm. (See "New Developments in Combination Controls.")

Avigation

Flying-Track Control. Information is given briefly about improvements in the Decca navigator system. The Decca navigator normally displays coordinates of the aircraft's position on three indicator dials, the reading of any two of which, when plotted on a special chart, fixes the position of the aircraft. Thus, for any flight a list of values of the indicator readings could be compiled and the flight made by flying in such a manner that the two indicators read, in turn, all the tabulated values. A track-control unit has been added which does this complex operation automatically. A film record is made which bears all the values of the various fixes for the intended flight. Before take-off this film is inserted in the unit. During flight the movement of the film is controlled by the receiver, and the fixes obtained from the receiver are automatically compared with those recorded on the film. The results are displayed to the pilot on a set of instruments which tell him: (1) position with respect to track; (2) distance in miles along track to destination; (3) ground speed of aircraft; (4) minutes ahead of or behind schedule for flight. It is stated that most important of all the track-control unit features are those it makes available for traffic control at the airport. *Flight*, September 19, 1946, Vol. 50, No. 1969, pages 315, 316, 1 illus.

Control Systems

New Developments in Combination Controls. J. W. Kelly. Combination controls for aircraft are noted which, it is stated, present advantages of weight- and cost-saving. It is pointed out that manufacturing and operating experience over several years has provided knowledge that has made possible the production of more dependable and rugged units. The program for developing hydroelectric combinations and mechanical-hydraulic combinations is reviewed. The development of small electric motors for aircraft-accessory operations has made possible the designing and building of dependable motor-operated valves. New methods and advances in follow-up systems for hydraulic controls, utilizing basically mechanical, hydraulic, and electrical combinations, give the designer versatility with smooth hydraulic power. *Transactions of the A.S.M.E.*, October, 1946, Vol. 68, No. 7, pages 701–706, 13 illus.

Motor-Operated Linear Actuator. An electric-motor-operated linear actuator of the same dimensions as a hydraulic jack of the same operating capacity, and weighing only 11 lbs. 10 oz., was designed especially for wing-flap operation. The motor and entire mechanism form a completely self-contained unit of simple, compact design, the only outside elements being three connecting wires.

The actuator is designed for an average operating load of 3,500 lbs. tension and compression, but withstands a static load of 8,000 lbs. tension and 12,750 lbs. compression, with an ultimate load of 25,000 lbs. compression. Jack speed at average load is 1/4 in. per sec.; length of travel, 4 in., with longer stroke if desired. The motor is rated 1/2 hp. at average load, 28 volts d.c., 31 amp., intermittent-duty type. *Electrical Engineering and Manufacturing Corporation*, Los Angeles.

Airborne Voltage Regulator. The Sorenson Model D-500 a.c. voltage regulator is designed specifically for aircraft use. It employs lightweight fosterited transformers and is hermetically sealed to withstand climatic conditions. Specifications include the following: frequency range, 360–500 cycles; input voltage range, 95–125; output voltage range, 110–120; load range, 50–500 volt amp.; regulation accuracy 0.5 per cent.

Harmonic distortion is held within a limit of 15 per cent in standard models and a limit of 5 per cent can be obtained on special order. Transient recovery time is approximately 0.1 sec.

The D-500 was designed to withstand an ambient temperature range of −55° to 70°C. It weighs only 12.5 lbs. Additional models with greater power rating also can be provided. *Sorenson and Company, Inc.*, Stamford, Conn.

Education and Training

Technical Picture-Writing. Flight Lt. R. Dyrgalla. The use of symbols to represent pictorially such phenomena as speed, time, and acceleration is explained and illustrated. Their use is explained in connection with the program for imparting technical knowledge to those without much previous technical background and the visual methods of flight training successfully used by the R.A.F. The method of presenting the essence of flying instruction without formulas or lengthy description utilizes graphical representation of such factors as aircraft speed, wind direction, altitude, and visibility. For example, a three-dimensional drawing represents the time and acceleration factors in turns of 750-, 1,000-, and 1,250-m. radius at speeds of 210, 240, and 275 m.p.h. Another drawing represents the progressive increase in size of the target area during a dive or parachute descent. Suggestions are made for the visualization of other flight maneuvers. *Aeronautics*, October, 1946, Vol. 15, No. 3, pages 44–46, 16 illus.

Electrical Equipment

Control and Protection of Aircraft D-C Power Systems. B. O. Austin. Direct-current power systems on transport aircraft before World War II were small in capacity compared with present requirements. Present wide speed-range generators have twelve to 15 times the ratings used on old DC-3's, and system capacity on new transports may be 30 times greater and capable of sustaining fault currents greater than 5,000 amp. at 30 volts. The writer sets forth the requirements for the control and protection of d.c. power systems for modern aircraft. The use of 24-volt systems introduces possible troubles from arcing not experienced with the 12-volt system. Many of the simple principles used in the aircraft d.c. power and protective systems are those used extensively in land power systems where continuity of service is of first-degree importance. Cable, generator, overvoltage, frozen contactor, and generator overheating faults are isolated or indicated during all operating conditions. Otherwise the system functions normally and fully automatically to connect and disconnect the generators from the battery bus as required. Satisfactory operation under conditions of humidity, sand, dust, vibration, altitude, explosive gas fumes, and acceleration normal to aircraft has been achieved by designing with these extreme conditions in mind. Means for quick removal and replacement of the complete control panel by using standard radio plugs and receptacles provides ultimate ease in maintenance and involves no compromises with performance. Contactors for any given power system are designed and applied so that they will interrupt successfully without undue stress any top current value that can be obtained on the system at the point where the contactor is located. *Electrical Engineering*, November, 1946, Vol. 65, No. 11, pages 741–745 (Transactions), 12 illus.

Engine Parts and Accessories

Aircraft Ejector Performance. Frank A. McClintock and J. Hall Hood. This paper presents the results of work on the ejector problem carried out by the Research Department, United Aircraft Corporation, over the past few years. Equations are developed which, with the aid of empiric coefficients, enable one to estimate the performance of steady-flow ejectors pumping a fluid across a small pressure rise or drop. Experimental data are presented which support the theory and provide information on some variables not covered by the theoretic treatment. An analogy between steady and intermittent flow is presented which makes it possible to estimate the performance of ejectors used in cooling aircraft engines. A method of applying the results to the design of ejectors is suggested.

The principal uses for an ejector in aircraft-engine installations appear to be in those cases in which cooling would otherwise have to be obtained by the use of a fan or stalled cowl flaps, or in which the exhaust thrust could not otherwise be used because of flame, noise, or temperature. The results indicate that little gain in thrust can be obtained in an installation in which there is a pressure drop through the ejector so that pumping is not necessary. *Journal of the Aeronautical Sciences*, November, 1946, Vol. 13, No. 11, pages 559–568, 16 illus.

An Exploratory Study of Oil Grooves in Plain Bearings. D. Clayton. A preliminary investigation has been made of the influence of oil holes and grooves on journal bearing performance, to provide, in addition to fundamental information on fluid films in bearings, preliminary data for an ultimate analysis of the behavior of internal-combustion engine bearings. In the first part of the paper the effects of supplying oil to holes and grooves in the unloaded part of the bearing are investigated, the quantity of oil flowing through the bearing, the running temperature, and the coefficient of friction being recorded. Among the results shown are the important part the clearance space at the point of supply plays in the quantity delivered; the surprising drop of feed as a 90° circumferential groove is extended to 360°; the marked effect of quantity of oil on bearing temperature for small flows and the rapid drop in efficiency of oil cooling as the quantity rises; and the absence of a groove arrangement giving more efficient cooling than the others. Change of supply temperature and pressure have a much less than proportionate effect on bearing temperature and flow. Increase of clearance leads to a disproportionate increase of oil flow.

In the second part of the paper the effect of holes and grooves in the pressure film is explored. In this case measurements were made of the pressure at the crown of the bush when the hole there was closed, and of the flow when open, in addition to the previous observations. Among the results may be noted the relatively small initial flow through the crown hole in spite of the high pressure there when it is closed; the increase of the crown-hole flow at the expense of side flow as the groove is cut into the inlet film; and the relatively small changes in bearing temperature and coefficient of friction. Again, changes of oil-supply pressure and temperature had less than proportionate effects on flow and temperature of the bearing. A preliminary note is made of the decrease of load-line film pressure which was found as the temperature was increased. The temperature was also raised to cause incipient failure of the bush and it was found that the final temperature was independent of whether the crown hole was open or closed, yet there were indications of diminished film thickness for small grooves at natural running temperatures. The safety was decreased as grooves were cut in the loaded part of the bearing. Some indications of the magnitudes of the changes are given. *Proceedings of the Institution of Mechanical Engineers*, 1946, Vol. 155, No. 14, pages 41–48, 7 illus.

Spinning Intake. A ducted spinner developed for the Napier-Tempest annular radiator installation is designed to increase the air intake area and thus to improve the airflow. A cutaway drawing reveals that the ducted spinner consists of two concentric surfaces, the inner one being a conventional spinner housing and the outer providing a central ram-head air intake that is supported by the faired airscrew-blade cuffs built on to the normal spinner. Thus, the intake form is that of an annular duct split helically into four passages by the blade fairing cuffs. These latter four passages are of airfoil shape, and their "pitch" setting may be selected during design in order to produce the optimum static head increase for the critical climb or ground-running condition. Comparative performance data for the ducted spinner and an orthodox radial installation are presented in a table. *Flight*, October 3, 1946, Vol. 50, No. 1971, pages 367–369, 6 illus.

The Further Development of Heat-Resistant Materials for Aircraft Engines (Translation of "Über die Weiterentwicklung Warmfester Werkstoffe für Flugzeugtriebwerke," *Luftfahrtforschung*, Vol. 14, No. 4/5, April 20,1937). Franz Bollenrath. The present report deals with the problems involved in the greater utilization and development of aircraft engine materials, and specifically with piston

materials, cylinder heads, exhaust valves, and exhaust gas turbine blading. The blades of the exhaust gas turbine are likely to be the most highly stressed components of modern power plants from a thermal-mechanical and chemical standpoint, even though the requirements for exhaust valves of engines with gasoline injection are, in general, no less stringent. For the fire plate in Diesel engines the specifications for mechanical strength and design are not so stringent, and the question of heat resistance, which under these circumstances is more easily obtainable, predominates. The development of materials for exhaust gas turbines will primarily be based on the proved, well-known, and still suitable exhaust gas materials, several of which are given. *National Advisory Committee for Aeronautics, T.M. No. 1093*, September, 1946.

Load Capacity of Aluminum-Alloy Crankpin Bearings as Determined in a Centrifugal Bearing Test Machine. E. Fred Macks and Milton C. Shaw. The load capacities of four aluminum-alloy radial-engine crankpin bearings were determined in a centrifugal bearing test machine. All the alloys had a load capacity in excess of 6,000 lbs. per sq.in. The average load capacity for the best alloy of the group (0.93 per cent copper, 1.29 per cent iron, 1.14 per cent nickel, 0.19 per cent silicon, 6.07 per cent tin, 90.38 per cent aluminum) was greater than 9,000 lbs. per sq.in. The aluminum-alloy bearings were found to seize more suddenly and severely than comparable copper-lead or silver-lead-indium bearings.

Chemical analysis made after the bearings had been tested to failure showed that the actual composition of each aluminum alloy was different from the chemical specifications. In particular, the iron content was found to be in excess of that required by the nominal specifications. Inasmuch as the iron content is reported to influence the antiscore properties of aluminum alloys, due consideration should be made of the actual composition rather than the nominal specifications in evaluating the aluminum alloys tested.

The physical characteristics of the bond between the aluminum alloy and steel back must be improved before the aluminum alloys can be used for radial-aircraft-engine master-rod bearings. *National Advisory Committee for Aeronautics, T.N. No. 1108*, August, 1946.

Strain-Gage Study of Internally Cooled Exhaust Valves Having Various Throat Designs. Arthur G. Holms and Richard D. Faldetta. Strain-gage tests to compare the strain-distribution characteristics of three exhaust valves having the same external contours in the region of the throat were conducted at the N.A.C.A. Cleveland laboratory, to determine a method for obtaining increased coolant-flow area without increasing stresses. One of the test valves had a relatively small coolant-flow area, whereas the other two had larger coolant-flow areas. The strain distributions for the three valves were compared for an axial tensile load of 1,000 lbs. The valves were statically loaded to simulate stresses in the throat region caused by valve closure. Tests showed that a constriction in the coolant-flow passage can be removed without increasing stresses. Such an increase in the coolant-flow area lowers the crown temperature. *National Advisory Committee for Aeronautics, T.N. No. 1116*, August, 1946.

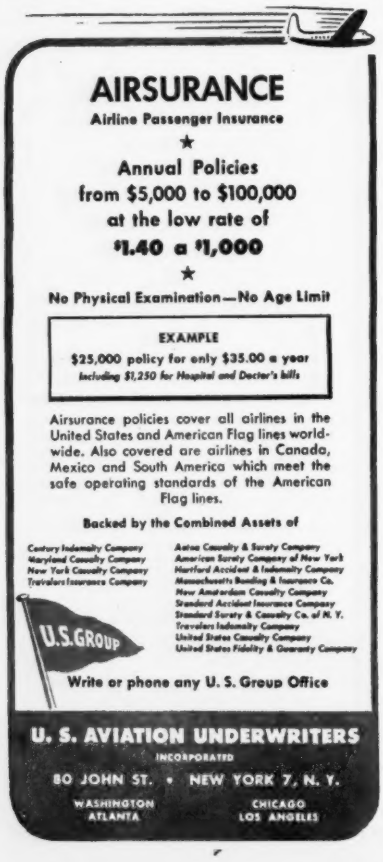
Exhaust System for Light-Plane Engines. The new Ryan muffler for light-plane engines incorporates four functions: (1) a complete exhaust system; (2) a muffler that eliminates 90 per cent of the engine noise; (3) provision for heating the carburetor air; and (4) provision for delivering heat to the cabin for passenger comfort. It is fabricated from the same heat-resistant steel alloy developed for use in large, high-power engines for military and commercial transport planes. The present production models of the muffler are available for four-cylinder "flat" engines from 65 to 85 hp., but development work is under way to provide similar mufflers for the higher-power engines used in some of the newer private and light commercial planes. It is reported that the muffler has demonstrated carburetor heat-rise characteristics in excess of Government specifications which require a 90°F. rise with 30°F. outside air temperature at 75 per cent engine power.

The muffler can be installed without the necessity for removing the propeller or engine accessories. The manufacturers state that there is less than a 2 per cent power loss from back pressure as a result of using the muffler. *The Ryan Aeronautical Company.*

Engines, Gas Turbine

Precision Sheet-Metal Work. Part II of a serial article concludes a review of the sheet-metal practice followed by Joseph Lucas (Burnley) Ltd. in the fabrication of parts for aircraft gas turbines. Details are given about the manufacture of turbine nozzle-ring assemblies and exhaust units. The special tooling for gas-turbine assemblies is explained. Operations on the machined parts of the assemblies and the machines used are described and illustrated.. *Aircraft Production*, October , 1946, Vol. 8, No. 96, pages 465–476, 36 illus.

Grinding Dovetail Serrations on Aircraft Turbine Buckets. G. V. Keller. A method of grinding serrations on gas-turbine buckets developed during the late war is described. Because the bucket material was too hard to mill or broach satisfactorily, the crusher-roll grinding method was adopted by the General Electric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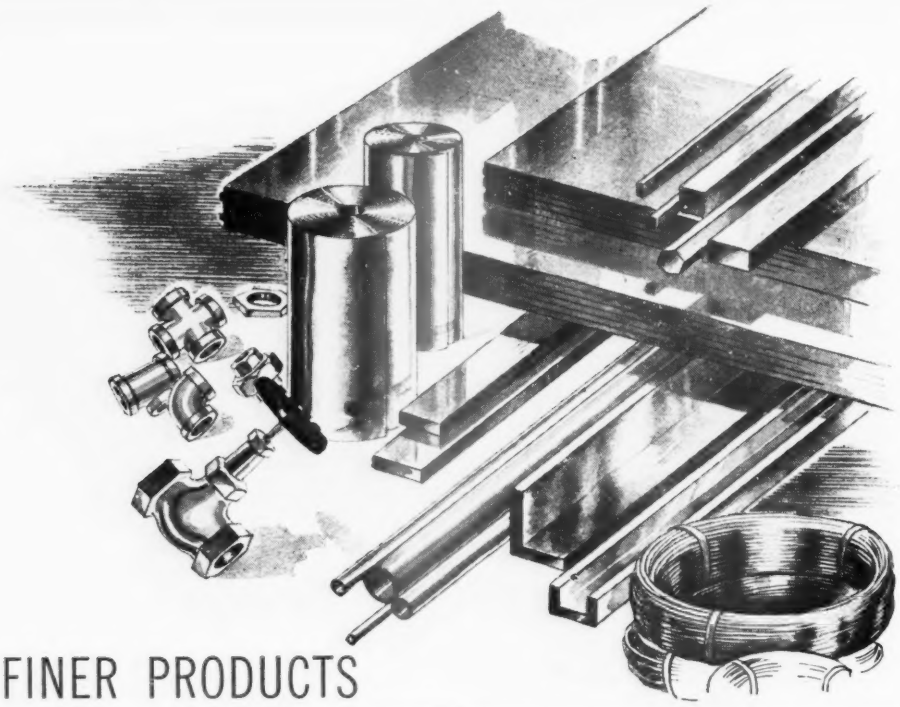

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Company and perfected with the cooperation of machine-tool builders experienced in this grinding procedure. Particulars are supplied about the bucket-serration grinding fixture, grinding operations, the crushing of the grinding wheel, and the crusher rolls. *Machinery*, October, 1946, Vol. 53, No. 2, pages 146–152, 11 illus.

Performance Parameters for Jet-Propulsion Engines. Newell D. Sanders. Performance parameters for jet propulsion engines have been developed from the concepts of flow similarity, inertia forces, elastic forces, viscous forces, and thermal expansions of the working fluid. The analysis relates performance to the geometry of the boundaries, Mach Number, Reynolds Number, and total-temperature ratio. The results of performance tests with turbojet engines are expressed in terms of two types of generalizing parameter—dimensionless parameters, and "corrected" parameters that are not dimensionless. *National Advisory Committee for Aeronautics, T.N. No. 1106*, July, 1946.

Small British Turbine-Propeller Unit. The Armstrong Siddeley Mamba turbine-propeller engine was designed to meet the need for a unit of that type of smaller power than those heretofore built. It generates power equivalent to 1,000 hp., to which is added 320 lbs. of thrust from the jet at sea level, the total power being equal to 1,120 hp. of a reciprocating engine. The Mamba weighs 750 lbs. and its diameter over the cowling is 27 in. The overall length, including the jet pipe, is 9 ft. 3 in. It has an axial-flow compressor providing straight-through flow. *The Society of British Aircraft Constructors Ltd.*

Engines, Reciprocating

Piston Lubrication Phenomena in a Motored Glass Cylinder Engine. S. J. Beaubien and A. G. Cattaneo. A study of the factors involved in piston lubrication was made with the aid of a specially built small-bore engine equipped with a glass cylinder. The engine was built with a glass cylinder to permit visual observation of oil, piston, and rings by stroboscopic and photographic means. Details are given about the design of the engine, and the visual study of the piston ring and oil relationship, which was made to gain some insight into the movement of oil in the ring belt during engine operation, and into the action and movement of the piston rings by which the oil movement is largely determined. The work was carried out by rotating the crankshaft of the engine without combustion by means of an electric motor, which made possible a study of the effects of mechanical forces but not the effects of the heat and pressure of combustion. One result of the investigation was the discovery that the major portion of oil consumption takes place on the exhaust stroke. *SAE Journal*, October, 1946, Vol. 54, No. 10, pages 60–67, 11 illus.

Advantages of Water Injection. F. J. Wiegand and D. W. Meador. The effects of water injection in improving the performance of reciprocating engines for aircraft use are studied, the principal contribution being in inhibiting detonation and augmenting cooling, as well as increasing power output. An explanation is given of how the injection of water and other liquids affects the operation of the engine, and the results are compared with other possible means of achieving improved performance, such as the use of the new superfuels now in course of development, the injection of chemical gases, or by changing the engine design. Savings in costs are taken into consideration as well as the engineering factors involved, and it is concluded, among other things, that if both detonation control and temperature control are required, water injection provides the most practical solution at present except for short-range aircraft, in which a larger engine would be more economical. *Aero Digest*, October, 1946, Vol. 53, No. 4, pages 84–86, 152, 154, 157, 158, 6 illus.

Lycoming XR-7755 Aircraft Engine. The A.A.F. Lycoming model XR-7755 aircraft engine develops 5,000 hp. at 2,600 r.p.m. for take-off and 4,000 hp. at 2,300 r.p.m. for continuous operation. The engine is a 36-cylinder, single crankshaft, liquid-cooled, radial type with cylinders arranged in four rows of nine each and having a total piston displacement of 7,755 cu.in. Some of the accessories are mounted conventionally at the rear of the engine, but others, including starters (two required), tachometers, and propeller governor, as well as the low-tension magnetos and distributors, are located ahead of the front row of cylinders.

The propeller drive is through a two-speed dual-rotation reduction gear, either ratio of which can be used at the pilot's discretion to obtain maximum propeller efficiency. The shifting is accomplished hydraulically and provides a direct drive to each of the two propeller shafts without the use of a friction clutch. Another feature is the use of camshafts, with two separate sets of cams which can be shifted to change the valve timing for maximum power or cruising economy. In conjunction with this feature, the ignition timing also is adjustable and is operated by the same mechanism that shifts the camshafts.

Specifications include the following: cylinder bore, 6.375 in.; stroke, 6.750 in.; supercharger, single speed, single stage, with impeller diameter of 14.4 in. and impeller ratio of 6.0 : 1. Propeller drive has a two-speed gear reduction, providing a high ratio of 0.2460 and low ratio of 0.3536. Dimensions are length, 121.35 in.; width, 60.50 in.; height, 66.25 in.; and diameter, 61.00 in. The total weight is 6,050 lbs. *Army Air Forces, Office of Public Relations.*

Use of Ducted Head Baffles to Reduce Rear-Row Cylinder Temperatures of an Air-Cooled Aircraft Engine. Michael A. Sipko, Charles B. Cotton, and James B. Lusk. The effectiveness of ducted-head baffles in reducing temperatures of rear-row exhaust-valve seats was determined from tests with a two-row radial engine. Two types of ducted-head

U.S. Army Air Forces Photo

Lycoming XR-7755, 5,000 hp. aircraft engine surrounded by production models of the Lycoming O-235-C. It would require 50 of these smaller engines to equal the large unit in power. (See "Lycoming XR-7755 Aircraft Engines.")

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baffle were investigated in flight. A reduction of approximately 50°F. in the average temperature of the rear-row exhaust-valve seat was obtained in flight and the reductions were reasonably consistent for all cylinders, ranging between 35° and 80°F. During level flight, the maximum temperature of the exhaust-valve seat obtained when using ducted baffles on all rear-row cylinders was reduced 50° to 70°F. below the maximum temperature obtained when using conventional baffles on all rear-row cylinders. *National Advisory Committee for Aeronautics, T.N. No. 1053,* August, 1946.

Flight Investigation of the Cooling Characteristics of a Two-Row Radial Engine Installation. Part II: Cooling-Air Pressure Recovery and Pressure Distribution. E. John Hill, Calvin C. Blackman, and James E. Morgan. Flight tests have been conducted at altitudes of 5,000 and 20,000 ft. to investigate the cooling-air pressure recovery and distribution for a two-row radial engine enclosed in a low-inlet-velocity cowling of a twin-engined airplane. The effect of flight variables on average recovery and circumferential, radial, and longitudinal distribution are presented for level flight; also included is a comparison of pressure-drop measurements across the engine, as indicated by nine different combinations of pressure tubes.

The results of these tests showed that pressure recovery and distribution can be greatly affected by changes in flight variables. Those variables having the greatest effect were cowl-flap angle, angle of attack of the thrust axis, and the propeller-thrust disc-loading coefficient. The tests further showed that large differences, sometimes amounting to 100 per cent, were obtained in the results indicated by various methods of measuring pressure drop across the engine.

On the basis of the results, it is observed that an important consideration in the design of cowlings and cowl flaps should be the obtaining of good distribution of cooling air, as well as minimum drag for the installation. The fact that these tests showed that the front recovery decreased with an increase in propeller-thrust disc-loading coefficient provides additional evidence that the recovery is greatly affected by the combined propeller-nacelle design. Also of significance is the fact that a large increase in front recovery in these tests resulted in a similar increase in rear pressure, indicating that an increase in the front recovery of an air-cooled engine is not always an effective method of increasing the cooling-air flow. *National Advisory Committee for Aeronautics, T.N. No. 1109,* July, 1946.

Engines, Rocket

On the Theory of Rockets. J. Ackeret. This is a translation of a paper on rocket theory which appeared in *Helvetica Physica Actia,* April, 1946. The subject is discussed from the point of view that energy of a different order of magnitude from that heretofore considered is available. The elementary theory of the masses and velocities of the rocket and jet is set forth. The calculation of formulas for extremely high jet velocities is carried out by means of relativistic equations. The application of nuclear energy to rocket propulsion then is considered. *The Bulletin of the British Interplanetary Society,* September, 1946, Vol. 1, No. 8, pages 37–46, 4 illus.

Gliding and Soaring

Schweizer's Proposed High-Performance Sailplane. Paul Schweizer. Particulars are given about a high-performance sailplane designated as the "One Twenty-One," which the Schweizer Aircraft Corporation is planning to develop. It will be a Class 1 glider of aluminum-alloy construction except for fabric covering of the aft portion of the wing and moving control surfaces, where balancing considerations may affect the type of construction. The sinking speed will be the minimum practical obtainable within limits of size, cost, and maneuverability. The use of ballast will permit a wide range of flight characteristics. A design speed of 145 m.p.h. is used, giving a placard speed of 130 m.p.h. A longitudinal trimming device is incorporated and controls are designed to give adequate control and stability, keeping the control forces as well balanced as possible for ease of flying and to eliminate undue fatigue. Preliminary performance data are included. The glider will have a span of 51 ft.; length of 22 ft. 16 in.; wing area of 156 sq.in.; and a weight empty of 380 lbs. *Soaring,* September-October, 1946, Vol. 10, Nos. 9–10, pages 8–10, 3 illus.

Towed Tailless. With the advent of the British Ministry of Aircraft Production research program in 1943, which included full-scale flight tests of tailless aircraft, General Aircraft, Ltd., was given the task of producing some experimental gliders. The article describes the first of these gliders, the GAL-56, and some of the research work connected with its development. To provide experimental versatility, a series of different wings, all having common attachment points for anchorage to a standard nacelle, was designed. The specifications of this tailless glider are listed and its design features are illustrated. *Flight,* September 26, 1946, Vol. 50, No. 1970, pages 327–330, 11 illus.

Auxiliary-Powered Glider. The Nelson Dragonfly is a glider powered by an auxiliary 2-cycle, 4-cylinder magnesium engine developing 25 hp. at 3,900 r.p.m. The engine weighs slightly less than 50 lbs. and is equipped with a 3-gal. gasoline tank that will permit more than an hour's intermittent cruising at 65 m.p.h. The engine was designed by the Nelson organization to eliminate the use of tow rope or wire in lifting the glider into the thermals. The engine is also used "between thermals" and upon landings, as well as during take-offs.

Other design features are a tricycle retractable landing gear, a Plexiglas bubble canopy, dual controls for side-by-side pilots, wide cockpit for two occupants, a dural boom extending from the fuselage and supporting the tail surfaces, and detachable wings. The Dragonfly was developed from the original design of its experimental prototype, known as the Bumblebee, which was a lighter craft with considerably less power.

Performance figures, based on gross weight of 935 lbs., are as follows: cruising speed, 65 m.p.h.; rate of climb, 240 ft. per min. for the first minute of climb; sinking speed, 4.8 ft. per sec.; gliding ratio, 18 to 1; take-off run, 900 ft.; stalling speed, 38 m.p.h.; fuel consumption, 3 gal. per hour; power loading, 38 lbs. per hp. Other specifications are wing span, 47 ft. 4 in.; overall height, 6 ft. 10 in.; overall length, 20 ft.; wing area, 169.3 sq.ft.; aspect ratio, 13.25; weight empty, 550 lbs.; wing loading, 5.50 lbs. per sq.ft.; area horizontal tail, 23.5 sq.ft.; area vertical tail, 18.5 sq.ft.; area ailerons, 24.2 sq.ft. *Nelson Aircraft Corporation,* Los Angeles.

Hydraulic Equipment

Aeroquip Hydrauliscope. The Aeroquip Hydrauliscope is a high-speed electronic analyzer, used for checking and recording high-speed pressure phenomena incident to the operation of hydraulic systems. The instrument includes a direct coupled amplifier that is susceptible to low transient frequencies down to zero to permit the indication and recording of the absolute values of any transient. Output characteristics are flat up to frequencies of 20,000 cycles per sec., making the amplifier particularly suited to pressure phenomena which may vary from steady pressure to high-frequency pulsations in the normal operation of regulating valves or controls and with the occurrence of shock pressures and surges. It permits the tracing and recording of pressure reference lines and also permits direct calibration with the aid of a dead-weight gage tester or a test gage.

The Hydrauliscope translates the output of the pressure pickup to vertical deflections on a cathode-ray oscilloscope. Only two external connections are required: one to the pressure pickup and one to any standard 105- to 125-volt, 50 to 1,800-cycle power service. The instrument can be provided with attachments to permit a photographic record of the curves traced on the screen of the cathode-ray tube. Interchangeable guide plates may be inserted in front of the screen to provide direct calibration at standard scale factors. *Aeroquip Corporation,* Jackson, Mich.

Ice Prevention

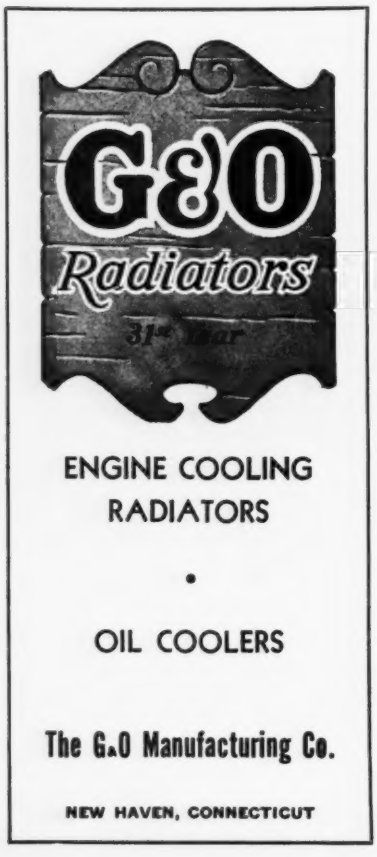
Some Suggested Specifications for Thermal Ice-Prevention System for Aircraft. L. A. Rodert. The general conclusions derived from research and development of the airplane thermal ice-prevention system are given, and further comments are made in a discussion of present knowledge. Details of design are discussed to indicate how some faults of early applications of the thermal system may be avoided. Specifications for the thermal system are given as an aid to operators and others desiring to provide the most effective protection against the formation of ice on airplanes to be designed for commercial or military use. *Transactions of the A.S.M.E.*, October, 1946, Vol. 68, No. 7, pages 781–789.

Instruments, General

Precision Tachometer for Use in Wind-Tunnel Testing. R. K. Fairley and H. L. Clark. The writers describe a high-speed, high-accuracy tachometer developed primarily to measure rotative speed during the power-testing of airplane models in wind tunnels by measuring the frequency of a tachometer generator. The frequency being measured is automatically compared with that of a tuning fork and indicated on an instrument having a scale length of 86 in. *Transactions of the A.S.M.E.*, October, 1946, Vol. 68, No. 7, pages 719–722, 8 illus.

Oils For Instrument Bearings. C. H. Braithwaite, Jr. The characteristics required of lubricants for the bearings of aircraft instruments are stated to be resistance to evaporation and to oxidation and physical deterioration; maintenance of viscosity at varying temperatures; and the provision of a film for protection of the bearing against corrosion and for adequate lubrication of the parts of the instrument. Details are given about tests to compare these properties of silicone oils with those of petroleum lubricants for instrument use. The results of the tests are explained and tabulated, and a chart shows the temperature-viscosity relationships of the different oils. *Aero Digest*, October, 1946, Vol. 53, No. 4, pages 94, 97, 3 illus.

A Failure-Sequence Indicator for Static Test Specimens. R. W. Powell. An instrument is described which has been used to determine the location of initial failure in static tensile-test specimens. Its particular usefulness in aircraft structural development is discussed and technical details of its operation are given. *Transactions of the A.S.M.E.*, October, 1946, Vol. 68, No. 7, pages 763–766, 10 illus.



Instruments, Flight

New Sperry Gyro Instruments. Six new gyro instruments, all designed to meet the demand for standard $3^{3}/_{16}$-in. panel cutout mounting and incorporating new features important to commercial and private flying, have been introduced by the Sperry Gyroscope Company, Inc. Three new versions each of direction-indicating and attitude-indicating instruments are currently in production.

Two of the three directional instruments are Gyrosyn compasses that operate electrically and, like earlier models, provide pilots with an indication of magnetic north without northerly turning error. Since the heading does not drift, periodic course resetting is not required. The C-2 model has a rotating pointer moving against a fixed dial. A reference marker or course setter is provided for convenience in turning to a new course or remembering an old one. The C-2A model features a rotating dial with fixed lubber line. Reciprocal headings are indicated through a window in the lower half of the instrument face.

To satisfy the requirements of the small personal airplane, the G-3 directional gyro has been developed as a companion instrument for the model F-3 air-driven attitude gyro. This instrument also has a fixed dial with a rotating pointer, but the pointer may be set so that the pilot always uses the upper quadrant. A course setter, as in the Model C-2 Gyrosyn, indicates the course to be flown. Special features of the G-3 are its nontumbling characteristic and its adaptability to standard mounting.

The Model H-3 gyro horizon, while not novel in the indication it provides, is a step forward in instrumentation in that its gyro is nontumbling, providing unlimited indication in bank and eliminating a caging mechanism with its attendant knob. In pitch, climbs or glides up to 27° can be indicated, although the gyro will not upset if this range is exceeded. The horizon instrument is constructed to meet the requirements of high-altitude flying and extreme temperature operation. Turn-error compensation is provided in this electrically driven instrument.

Equal in performance to the larger Model F-1 now in use, the new Models F-4 and F-4A attitude gyros are being produced for those pilots who prefer pattern indication. Like the Model H-3 gyro horizon, the gyros in these instruments are nontumbling and have been compensated for turn error. Both instruments are electrically driven and are built for high-altitude and extreme temperature operation. The Model F-4A differs from the Model F-4 only in that a supplementary sensitive pitch indication is provided to aid the pilot in determining the trim condition of his aircraft with a high degree of accuracy at points near level-flight trim attitude. *Sperry Gyroscope Company, Inc.*

Landing Gear

Noteworthy Landing Gear Types. Part II. The second section of a continued article about the landing gear used with various types of personal airplanes includes a description of the Electrol landing mechanism employed in the Republic Seabee and in the Commonwealth Trimmer. Other units described are the cross-wind gear developed by the Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation and the Goodyear Aircraft Corporation. The main landing gear of the Ercoupe is referred to as a "knee-action" type, the construction and operation of which are outlined. The Midwest Mercury's gear uses two aluminum-alloy leaf springs to absorb the landing shock. Also described are the electrically driven hydraulic assembly manufactured for the Globe Swift by Adel Precision Products Corporation and Engineering Laboratories, Inc., and the landing gear of the Funk Bee, which has an unusual tailwheel design. *Aero Digest*, October, 1946, Vol. 53, No. 4, pages 74–78, 9 illus.

Rotational Drop-Testing of Airplane Main Landing Gear. W. H. Gayman. The immediate physical objectives of drop testing are presented together with a general method for conducting rotational tests that have proper contact velocity and energy relationships coincidental with the absence of undesirable dynamic reactions at the pivot axis. Applications of the method to tests of the main landing gear of the Models PV-1 and PV-2 patrol bombers are discussed. Conclusions drawn from dynamic-load measurements emphasized the possibility of attaining

excessive loads in the drag-resisting structure when the impact surface is horizontal and the gear is inclined to simulate resultant loading of any particular design condition. It is implied that the practice of dropping the test gear on an inclined platform during translational drop tests may result in unconservative loading unless deliberate compensation is afforded. *Transactions of the A.S.M.E.*, October, 1946, Vol. 68, No. 7, pages 773–779 5 illus.

Maintenance

Repair of Stressed-Skin Airframes John T. Henshaw. The repair of air frames of the stressed skin type is discussed. The simplicity or difficulty of a particular repair depends more upon the position of the damage than upon the extent. For example, a small crack in a main-plane spar boom close to the root joint may be much more troublesome than an extensively damaged skin panel in the rear fuselage. Emphasis is placed on the importance of stress transfer because slight damage in a highly stressed region may call for a major repair. Regions of high stress cannot be defined in detail to cover all aircraft because of variations in design, but it is possible to name those components of the air frame which are heavily loaded under various conditions and to define features of design that cause high stresses to develop and that must therefore be regarded as danger points when assessing damage. These points are indicated in a diagram.

Points to be considered in making repairs are enumerated and discussed. Information is supplied about the skin-plating of a stressed skin air frame. Consideration is given to the materials used for repairs. Reference is made to difficulties encountered when using a repair material differing from that of the component to be repaired. An excessive potential difference may increase the danger of electrolytic corrosion. The electrical potential values of various metals are listed. *Flight*, October 10, 1946, Vol. 50, No. 1972, pages 395–397, 4 illus.

Recovering the Light Plane. George Watkins. A step-by-step description is given of the process of recovering an airplane with fabric. Particulars are supplied about estimating the material, sewing the fabric, and applying dope and finish. Illustrations show recovering operations. *Southern Flight*, October, 1946, Vol. 26, No. 4, pages 56–58, 7 illus.

Pump Test Stand. The Pacific Airmotive Model PA 830 aircraft vacuum and hydraulic pump test bench is designed to conduct C.A.A. and manufacturers' required tests on overhauled pumps, and to test all aircraft-type vacuum pumps used for instruments. In checking aircraft hydraulic pumps it will test pumps up to 3,000 lbs. per sq.in. pressure and flows up to 10 gal. per min. Power for the unit is provided by a 15-hp. motor with speed variation from 0 to 4,500 r.p.m. Speed is variable by a conveniently located rheostat. Power can be easily determined by using voltage and amperage readings. Complete power curves showing actual horsepower consumption of the pump are supplied with the stand, for power checks at recommended speeds.

The stand has complete instrumentation for checking vacuum and hydraulic pumps. Tests that can be performed include break-in, capacity temperature rise, oil flow, seal leakage, and power input. Standard accessories delivered with the stand include hydraulic and vacuum hose assemblies, two adapter plates, and standard pump spline drive. For checking the capacity of vacuum pumps, four sharp-edge orifice plates of various sizes, with curves converting manometer readings directly to cubic feet per minute, are included. An added feature necessary for checking the hydraulic pumps is the large thermostatically controlled oil tank containing both heater and cooling coils. The stand is of all-welded steel construction with steel cabinet and sump. The test bench is 84 in. long, 87 in. high, and 31 in. deep. *Pacific Airmotive Corporation*, Glendale, Calif.

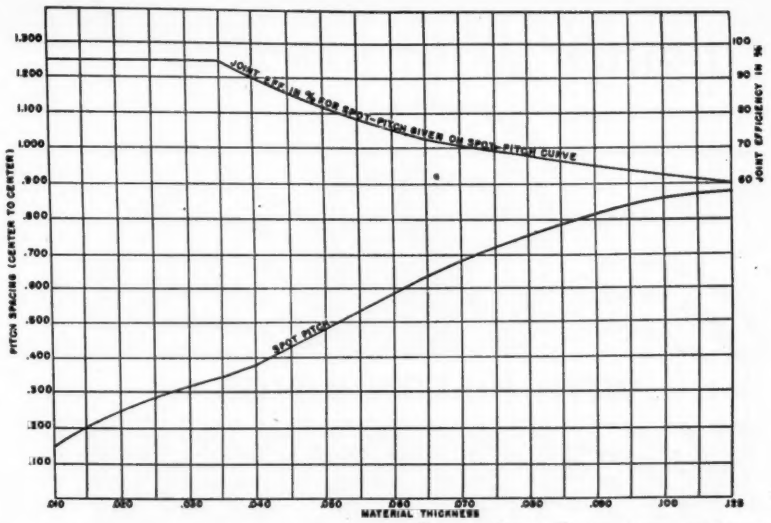

JOINT EFF. IN % FOR SPOT-PITCH GIVEN ON SPOT-PITCH CURVE
SPOT PITCH
PITCH SPACING (CENTER TO CENTER)
JOINT EFFICIENCY IN %
MATERIAL THICKNESS

Illustration Courtesy The Ryan Aeronautical Company

Spot weld pitch and joint-efficiency curves for single-row pattern. **(See "Spot Welding Techniques for Primary Structures," page 64.)**

Materials, General

Torque Values for Standard AN Bolts and Nuts. A brief article describes tests conducted by the Consolidated Vultee Aircraft Corporation to establish definite torque limits for sizes of bolts most commonly used in aircraft construction. Tables give recommended torque values for standard AN nuts and bolts, and the average percentage torque to produce a 30,000-lbs. per sq.in. root stress in all sizes of bolts. *The Iron Age*, October 10, 1946, Vol. 158, No. 15, page 59.

Directory of Materials. The October issue of *Machine Design* contains the thirteenth annual edition of a directory of materials. Sections are devoted to iron, steel, and nonferrous metals listed by trade names; stainless steels classified by American Iron and Steel Institute types; an index of alloys according to principal constituents; producers of iron, steel, and nonferrous metals; plastics listed by trade names; an index of plastics by type; producers of plastics. Other sections include nonmetallic materials listed by trade names; an index of nonmetallics according to type; producers of nonmetallics; producers of stampings; producers of forgings; machine die-castings producers; custom molders of plastics; and producers of machine finishes. *Machine Design*, October, 1946, Vol. 18, No. 10, pages 167–256.

Materials, Metals and Alloys

Effect of Tempering on Mechanical Properties. G. K. Manning and G. P. Krumlauf. The fact that different heat-treating shops make use of different practices in obtaining the same hardness in a given steel has led to the question of whether any advantage in mechanical properties could be assigned to a particular practice. In order to bring scientific understanding to the phenomenon of heat-treating, the Office of Scientific Research and Development initiated a series of tests on six quenched and tempered steels which are described in a two-part article. The artic'e shows some interesting relationships between (1) Brinell hardness and (2) tensile strength, yield point, elongation, and reduction of area, which were revealed by this extensive research. Quantitative data are presented to show that wide variations in tempering practice have no effect on the relationship be-

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TYPICAL PROPERTIES

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Tensile Strength, p.s.i.	41,200	72,400	108,800
Rockwell Hardness	101(B)	30(C)	33(C)
Brinell Hardness*	248	285	311
Elastic Modulus, p.s.i.	11.9×10^6	$17.-18. \times 10^6$	$22. \times 10^6$
Modulus of Rupture, p.s.i.	—	117,000	190,000
Izod Impact** (inch-pounds)	3	5	10/15

* By conversion.
** Comparative values obtained from breaking .14" x .26" x 3.0" bars in an inch-pound Izod test machine.

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tween the above-mentioned physical properties. The correlation that was found to exist between Charpy impact values and Brinell hardness, at room temperatures, at −40°, and at −80°F., is described. The article also gives the results of tests conducted to determine the effect of tempering practice on the relationship between these properties and of the influence of steels susceptible to temper brittleness on such correlation. *The Iron Age*, October 24, 1946, Vol. 158, No. 17, pages 44–50, 13 illus.; October 31, 1946, Vol. 158, No. 18, pages 50–55, 10 illus.

New Heat Resisting Metals for Engines. R. K. Winkleblack. A broad picture of what design and development engineers can now expect of alloys for high-temperature applications in internal-combustion engines is presented. Graphs and tables that were compiled originally for the National Defense Research Committee give the physical and metallurgic properties of new heat-resisting metals for engines. One graph shows the physical properties for a forged alloy used in turbine wheels, plotted against temperature. Some of the properties of metals used in production models of British gas turbines also are tabulated. *Automotive and Aviation Industries*, October 15, 1946, Vol. 95, No. 8, pages 40–44, 5 illus.

Forging for Stressed Fittings. Waldemar Naujoks. The Chief Engineer of the Steel Improvement and Forge Company reviews the factors that enter into the design and production of forgings for aircraft parts and fittings. Essential requirements for "aircraft quality" forgings include grain-flow position, grain structure, a minimum of impurities, and freedom from undue segregation, pipes, bursts, scabs, and flakes. Dimensional and weight tolerances, hardness and straightness tolerances, surface condition, and balance are other considerations desired for particular forgings. Defects and how to avoid them are outlined, and an extensive discussion is included on the methods of preparation, the steps in the forging operation, the control of temperature, inspection, and other points involved in correct forging practice. The production and use of impression dies is detailed, as well as the use of upset forgings. Precautions to be taken in designing for radii, fillets, pockets, recesses, ribs, and thin sections are set forth. The article concludes with an analysis of the causes of grain flow. *Aero Digest*, October, 1946, Vol. 53, No. 4, pages 82, 83, 165, 3 illus.

Precipitation Hardened Super Heat-Resistant Alloys. R. B. Gordon. The development of superior heat-resistant steels for gas turbines is discussed with particular attention to the activities of the Westinghouse Electric Corporation. The article describes the metallurgic and physical properties of K42B alloy, which was produced by modifying a strong heat-resistant nickel-cobalt-titanium alloy developed more than 15 years ago and known as Konal. Konal contained no chromium and could not be subjected to severe oxidizing conditions. The addition of chromium overcame this condition and resulted in the alloy K42B, which had superior properties. Because the precipitation hardening characteristics of K42B alloy made the alloy unsuited for optimum creep strength at 1,500°F., further research work was carried out. By the addition of molybdenum as a precipitation hardening agent the thermal stability was greatly increased. The superalloy finally developed is known as Refractaloy 70. The properties of K42B and Refractaloy 70 are compared. *Steel Processing*, September, 1946, Vol. 32, No. 9, pages 561–564, 584, 9 illus.

High Strength, High Temperature Alloy S-816. Thomas Y. Wilson. Research work was undertaken by Allegheny Ludlum Steel Corporation to meet the need for steels having greater strength ratings at high temperatures, principally for use in gas turbines and jet propulsion engines for aircraft, and also for other industrial applications. High strength, creep resistance, and resistance to the corrosive action of the products of fuel combustion are the primary considerations for such uses. As a result of the research work, several new alloys were developed possessing unusual strength at temperatures up to 1,500°F., of which the strongest has been designated S-816. The writer discusses the properties and characteristics of that alloy, beginning with the chemical composition and giving details about the methods of testing, heat-treatment, fabrication, and applications. The conditions under which the tests were conducted are outlined and methods of heat-treatment are indicated, with tabulated figures showing rupture stresses, quenching temperatures, hardness ratings, aging periods, and other data. It is shown that S-816 can be fabricated by all of the usual processes, and recommendations are made for the necessary variations in such processes to get the best results from the special properties of the material. *Materials & Methods*, October, 1946, Vol. 24, No. 4, pages 885–890, 5 illus.

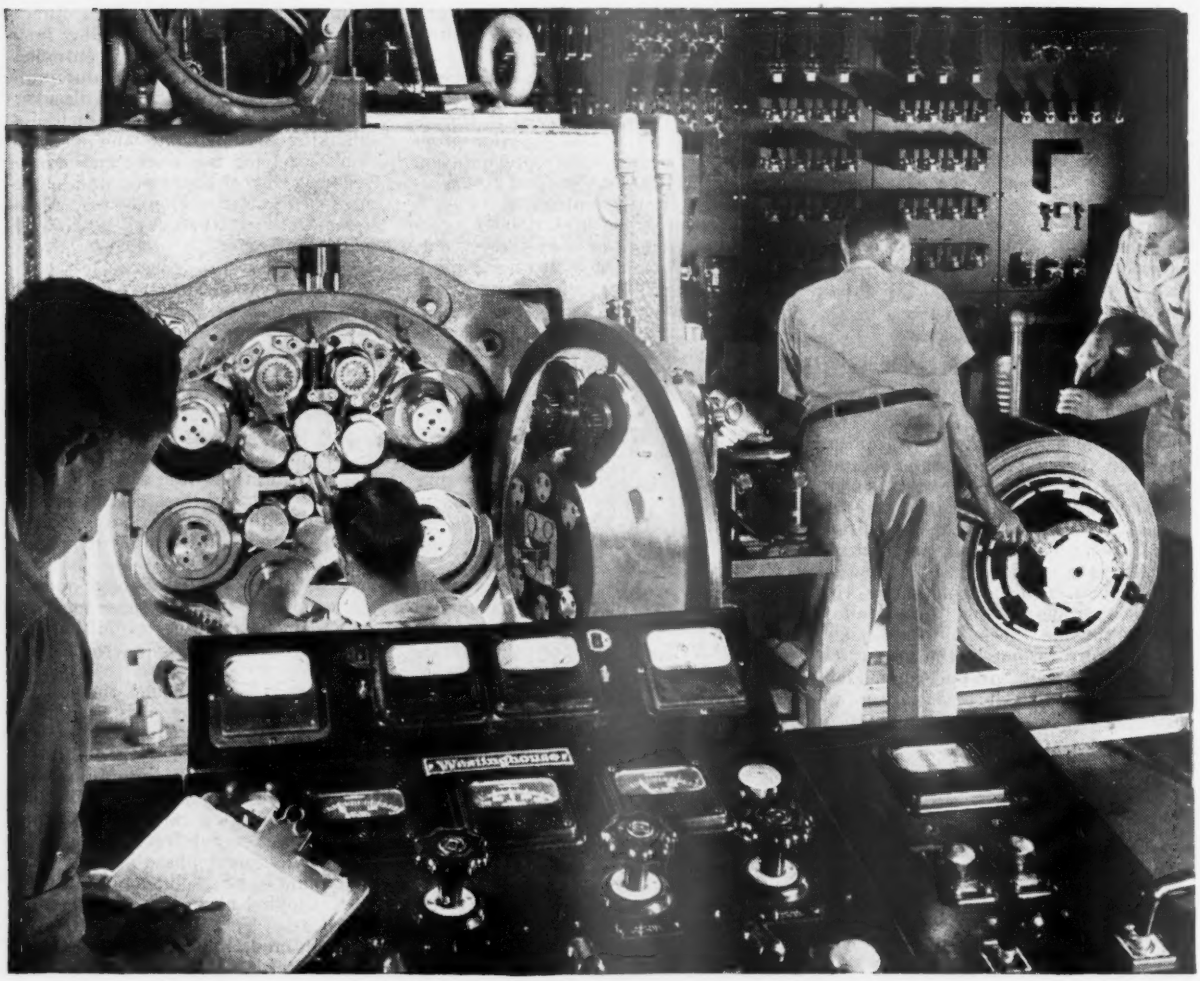
Mechanical Working of Aluminium Alloys—I. R. Groves. The working of aluminum and its alloys, which can be carried out by a wide range of methods, is explained in a serial article of which this is the first installment. The principles of cold working are discussed. The importance of mechanical properties is stressed. A brief outline of the general types of aluminum alloys is provided as a guide to those who have not had the opportunity of studying present-day specifications. The characteristics of wrought aluminum alloys that have not been heat-treated and those that have been so processed are defined, and these commercial applications are enumerated. Considerations affecting the choice of the right alloy for a particular operation are mentioned. Having briefly outlined the aluminum alloys available, the writer discusses various working operations, including blanking and piercing, and also the tools used for the work, methods of securing correct alignment, and blanking clearances. *Engineering Materials*, October, 1946, Vol. 4, No. 14, pages 435–437.

The Crystal Structure at Room Temperature of Eight Forged Heat-Resisting Alloys. J. Howard Kittel. Current gas turbines and jet propulsion engines are greatly limited in performance by the maximum temperatures at which the component metal parts may operate without failure. Such failures may occur in the form of actual fractures, intercrystalline corrosion, distortion due to temperature gradients and centrifugal stresses, and excessive elongation due to creep. The suitability of a metal part for withstanding highly adverse operating conditions, such as those found in gas turbines and jet propulsion engines, is often largely determined by its crystal structure.

In order to determine the crystal structure of some currently used heat-resisting alloys, a preliminary investigation of eight leading forged alloys—S816, S590, Gamma Columbium, Hastelloy B, 16-25-6, 19-9 DL, Nimonic 80, and N155 (low carbon)—was conducted by X-ray diffraction methods. The predominant phase in each alloy was found to be a solid solution of the chief alloying elements. The crystal structure of the solid solution was the face-centered cubic type. Alloys S816, S590, and Gamma Columbium, which contained the largest percentages of columbium, were found to show diffraction lines from a second phase that is believed to be columbium carbide. *National Advisory Committee for Aeronautics, T.N. No. 1102*, July, 1946.

Materials, Plastics and Plywood

Thermal-Expansion Stresses in Reinforced Plastics. Philip S. Turner. In the preparation of plastics heretofore it has been found practically impossible to produce a satisfactory bond between a plastic and a metal facing or other metal reinforcement. This is largely due to the difference in coefficients of expansion of the materials. The report describes a method of compounding a plastic, or other mixture or compositions, to provide a material having a predetermined desired coefficient of thermal expansion. Failure of adhesive bonds is attributed to boundary stress concentrations. An analysis of the causes of internal-stress concentrations in rigid adhesive layers leads to the conclusion that stress concentrations can be eliminated in many cases by matching the coefficients of thermal expansion of the component parts. A stress-equilib-



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rium formula is derived for calculating the thermal-expansion coefficients of mixtures which involves the density, modulus of elasticity, coefficient of thermal expansion, and proportion by weight of the ingredients. Illustrations of the application of the derived formula include lead-antimony and beryllium-aluminum mixtures, phenol formaldehyde resin and glass-fiber mixtures, and plastic plywoods. The thermal-expansion coefficients of a number of pure and reinforced plastics are reported. It is shown that bonds obtained when thermal coefficients are matched are stable over a wide range of temperature. *Journal of Research of the National Bureau of Standards*, October, 1946, Vol. 37, No. 4, pages 239–250, 8 illus.

Theory of Sandwich Construction. Part I. A. Garrard. Part I of a two-part article presents information for aircraft designers regarding the structural qualities of sandwich structures comprising thin strips or sheets of metal or plywood connected to backing or supporting members of light rigid expanded materials. The properties of five types of reinforcing material are listed and the processes of manufacture are described. Structural problems, including the collapse of long columns; stressed skin structures; structure loading; bending and buckling; and factors of safety are discussed. *British Plastics*, September, 1946, Vol. 18, No. 208, pages 380–388, 7 illus.

Impact Strength and Flexural Properties of Laminated Plastics at High and Low Temperatures. J. J. Lamb, Isabelle Albrecht, and B. M. Axilrod. The Izod-impact strengths and flexural properties of several types of plastic laminates, which either are in use or have potential application in aircraft structures and parts, were determined at different temperatures in the range of −70° to 200°F. The materials investigated were unsaturated-polyester laminates reinforced with glass fabric and phenolic laminates reinforced with asbestos fabric, high-strength paper, rayon fabric, and cotton fabric. Both high-pressure and low-pressure types of cotton-fabric phenolic laminates were included.

The impact strength of specimens tested flatwise at 77°F. was 4 to 7 ft.-lbs. per in. of notch for all the laminates except the glass-fabric and rayon-fabric laminates. These two materials had impact strengths of 31 and 17 ft.lbs., respectively, at 77°F. The high-strength-paper, rayon-fabric, and asbestos-fabric phenolic laminates showed small changes in impact strength between −70° and 200F°. Cotton-fabric phenolic laminates showed pronounced decreases in impact strength at the low temperature, and small changes between 77° and 200°F. The glass-fabric unsaturated-polyester laminates had increased impact strengths at the low temperature.

The flexural strengths and moduli of elasticity of all the materials increased with changes in the test temperature from 77° to −70°F. Under exposure to a 200°F. temperature, all materials except the asbestos-fabric laminate lost 30 to 40 per cent of their flexural strength at 77°F. and the moduli of elasticity of all the materials, except the asbestos-fabric and one cotton-cloth phenolic laminate, decreased about 20 per cent.

Tests made at room temperature after heating the materials at 200°F. for 24 hours indicate that prolonged heating with consequent loss of moisture content and further cure of the resin may offset the effect of high temperature alone. In flexural tests made at 150°F. and 90 per cent relative humidity two laminates showed considerable loss in strength. *National Advisory Committee for Aeronautics, T.N. No. 1054*, August, 1946.

Glass Aircraft Wing. An experimental glass-fiber aircraft wing was successfully tested at Wright Field recently. Constructed of a new basic material composed of 55 per cent glass fibers and 45 per cent resin, this wing incorporates a new concept of structural design. Instead of laminating glass fibers in a manner similar to the standard metal practice of sheet stringer combinations utilized in wing design, a sandwich construction was developed comprising a low-density core material (cellular cellulose acetate) set between thin high-strength inner and outer skins of glass-reinforced laminates.

The wing represents a complete departure from the contemporary design of metal wings. The sandwich-type construction provides a clean interior entirely free of obstructions, such as ribs and other structural bracing. The experimental wing was made in two halves, using molds of relatively simple construction. The beam-flange elements were molded into each half and the halves were then joined together longitudinally. The total number of structural parts in the new wing is six.

The basic process involved in the fabrication of a laminated glass wing is as follows. Cloth woven from glass fibers is impregnated with resin in a simple semiautomatic coating machine. Layers of the impregnated cloth are laid in inexpensive molds conforming to the finished contour of the wing. Strips of lightweight cellular cellulose acetate, having a density of 6 lbs. per cu.ft., are wrapped with a thin layer of glass cloth to form the core of the sandwich. These strips are then laid on face plies of impregnated glass cloth in the mold. Next, additional plies of impregnated glass cloth are laid over the core to complete the sandwich.

To cure this wet lay-up into a strong solid structure it is necessary to apply pressure and heat. Accordingly, there is placed over the entire lay-up a blanket sealed at the edges. By drawing a vacuum between the blanket and the mold the normal pressure of the atmosphere is utilized to exert the necessary force (about 14.7 lbs. per sq.in.) to mold the sandwich assembly. This assembly is then placed in an oven where it is baked 1 hour at 220°F. The resin, glass fibers, and cellular cellulose acetate core are fused and hardened into a lightweight structure of great stiffness and smoothness. One of the advantages of the process is that no skilled labor is required in the actual fabrication of the wing.

The repair of glass-cloth sandwich structures would differ considerably from the sheet-metal processes. Plastic structures can be repaired without altering the integrity of the structure. A glass-fiber patch can be applied to a damaged wing in a manner similar to that employed in vulcanizing a patch on a tire. A piece of impregnated cloth is smoothed on the damaged area and cured by heat lamp or sunlight. Firing tests on the new glass laminates showed that they had the desired characteristics, and 20-mm. high-explosive shells failed to detonate in penetrating the sandwich. *Army Air Forces, Air Matériel Command.*

Testing Adhesives for Aluminum. Fatigue tests made on two pieces of $^1/_{16}$-in. thick Duraluminum cemented together with a plastic adhesive have shown that the adhesive actually is stronger under bending stresses than is the metal itself. The tests were conducted by the Sonntag Scientific Corporation on a Baldwin Model SF-01-U universal fatigue-testing machine as a part of a series conducted for the American Society for Testing Materials.

Fifteen specimens of the 24S-T aluminum alloy were used in the tests. The adhesives tested were Cycleweld, a product of the Chrysler Corporation, and Redux, made by the Resinous Products and Chemical Company. Repeated alternating loads up to five million load cycles were applied to the specimens and in all cases except one the adhesive held while the metal itself fractured. The adhesive parted in only one of the tests. These tests, which simulated actual service, indicate that it may be possible to use the adhesive to "glue" metal aircraft parts together rather than to rivet them. *The Baldwin Locomotive Works*, Philadelphia.

Molded Silicone Rubber for Aircraft and Engine Parts. Molded G-E silicone rubber parts are used in large aircraft where high-temperature resistance and low-temperature flexibility are required, such as gaskets in high-power engines, in jet engines, and in a new type of oil seal for high-speed shafts at temperatures of 350° to 400°F. Preliminary tests have indicated that ice has less tendency to stick to silicone rubber than to other rubber stocks. This characteristic and the excellent heat resistance of silicone rubber to hot, dry air suggest its use in deicing equipment on airplanes. It also is expected that the need for such a material will increase

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as the skin temperatures of high-speed planes increase due to air frictional effects.

G-E silicone rubber possesses heat resistance to a degree that it remains practically unaffected when subjected to temperatures ranging from −55° to 520°F. It is chemical and moisture resistant, provides excellent electrical insulation, and will not adhere to metals or other materials at high temperatures. The material is available in extruded shapes, molded parts, sheet stock, or fabricated stocks. Extruded rubber is available in rods, tubes, flat strips, or a large variety of shapes for which a die may be made. Sheet stock is available in thicknesses of 1/32 in. to 3/4 in. and also may be reinforced with plies of glass and asbestos cloth to give greater strength. Molded parts can be made in any of the conventional types of compression molds. Silicone-rubber-coated glass cloth also is being produced. *General Electric Company.*

Materials, Protective Coating

Insulation of Dissimilar Metal Faying Surfaces. Bernard W. Floersch. To determine the optimum organic insulation necessary for protection against galvanic corrosion in various dissimilar metal contacts, the series of tests reported in this article was conducted at the laboratory of The Ryan Aeronautical Company. Study specimens were fabricated and tested in a salt-spray cabinet. The tests were not correlated with actual service conditions but were designed to show the comparative corrosion resistance of definite dissimilar metal contacts having various finishing schemes. Among the dissimilar metals studied were 24S-T dural with cadmium-plated 1025 steel; AMC52S-H magnesium with 18-8 stainless steel; AMC52S-H magnesium with 24S-T dural; and AMC52S-H magnesium with 24 S-H Alclad. The test combinations that were prepared and given protective treatments are listed, and the conclusions reached in the investigation are set forth. *Automotive and Aviation Industries,* October 1, 1946, Vol. 95, No. 7, pages 37, 88, 90, 2 illus.

Meteorology

Meteorology and High Altitude Aviation. G. M. B. Dobson and A. W. Brewer. The regular operating heights of aircraft, both civil and military, are continually increasing until now regular flights within the stratosphere are planned. There is, therefore, much practical interest in the meteorological conditions to be found in the stratosphere and upper troposphere. These conditions are discussed with particular attention to temperature, humidity, and ozone content. Methods of measuring humidity at high altitudes and the use of the frost-point hygrometer for this purpose are described. In the latter part of the paper it is shown that the amount of ozone plays an important role in governing the temperature in the atmosphere. *The Journal of The Royal Aeronautical Society,* October, 1946, Vol. 50, No. 430, pages 787–806, 14 illus.

Recent Developments in Meteorological Equipment. Athelstan F. Spilhaus. Developments in meteorological measuring equipment and techniques during the war are described, including surface and aircraft instruments, balloon-borne equipment, and remote measurements without flight equipment. Reference is made to the aerograph, the English frost-point hygrometer, radio direction-finding wind equipment and radar winds-aloft sets, the aircraft parachute radiosonde, sferics, and radar storm detection. Although the account does not cover the topics in technical detail, it provides a summary of the trend taken in the development occasioned by wartime demands. *The Bulletin of the American Meteorological Society,* Vol. 27, No. 7, pages 399–409, 8 illus.

Naval Aviation

Rocket Armament of Douglas AD-1 Skyraider. Air-borne rocket power comparable to the guns of a light cruiser is provided by the armament of the Douglas AD-1 Skyraider. The rocket "artillery" capable of striking such a blow is carried on launchers mounted under the wings of the Navy's new attack-type aircraft.

The carrier-based AD-1 can mount 5-in. rockets or 12-in. "Tiny Tims," the largest rockets carried by aircraft. The Tiny Tims are 12 ft. long and weigh 1,300 lbs. each, having the striking power of a 12-in. battleship shell and the ability to penetrate 3 ft. of reinforced concrete. The Skyraider can carry its munitions load of 6,000 lbs. of rockets many hundreds of miles from its carrier before launching it. It is stated that the plane's full load of explosives can be released in 1 sec., and the missiles can be launched singly or in pairs. When released in "ripple fire," the missiles follow each other earthward 140 ft. apart at 1,500 m.p.h.

As an alternative to the rocket armament, the AD-1 can accommodate a 6,000-lb. load of bombs, torpedoes, fire-bombs, radar units, or extra fuel tanks, without the necessity for changing armament installations. *Douglas Aircraft Company, Inc.*

Private Flying

Stop Selling Aviation to Ourselves! T. P. Wright. The Administrator of Civil Aeronautics discusses the need for a personal plane that will be a vehicle of utility and explains how the C.A.A. has dedicated itself to aid the industry to make such a plane an actuality. It is stated that the four fundamentals that must be built into this personal plane are reduction of noise; more performance at less initial cost; comparable reductions in maintenance and operation costs; and more safety features. Seven specific research projects that the C.A.A. has recommended to the National Advisory Committee for Aeronautics to implement this program, and on which the N.A.C.A. is now working, are

The rocket armament of the Douglas AD-1 Skyraider carrier-based Navy airplane includes batteries of 5-in. rockets and 12-in. "Tiny Tim" rockets. (See "Rocket Armament of Douglas AD-1 Skyraider.")

listed as follows: reduction of noise of both propellers and engines; gas turbine-propeller combination power plants; fuel with less fire hazard; power plant consisting of jet-driven propeller blades; windshield with smooth-water clearance, investigated at the Cleveland ice tunnel (this is to take the place of windshield wipers); reports summarizing N.A.C.A. work on control and stability at low speeds; and N.A.C.A. work on tail surfaces.

It is noted that at the same time the C.A.A. also is undertaking within the province of its own mandate from Congress a reduction in the number of regulations, complete elimination of those regulations that are onerous and do not contribute to safety, and is exploring other avenues of a regulatory nature which can be eliminated. Emphasis is placed on the importance of educating the public concerning the present and future community values of aviation. *Flying*, November, 1946, Vol. 39, No. 5, pages 17, 18, 60, 62, 3 illus.

Production, General

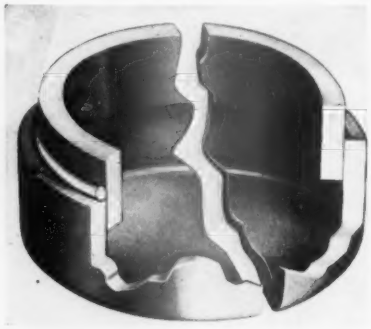
The Case for 100 Per Cent X-Ray Aircraft Castings. Justin G. Schneeman. The writer discusses the advantages accruing from the use of 100 per cent X-ray inspection of aircraft castings, in which radiographs are combined with fluoroscopic examination. The relationship between safety and adequate inspection procedures are stressed. A detailed examination is made of what are described as the erroneous assumptions involved in percentage examinations. *The Iron Age*, October 10, 1946, Vol. 158, No. 15, pages 56–58, 4 illus.

Job Evaluation Scales. Benjamin P. Hamilton. An analysis is made of a recent study of job-evaluation scales used by various companies and industrial associations. This study, made by the Jacobs Aircraft Engine Company, emphasizes the necessity of adequate factual support for the construction of an evaluation scale and points out the need for refinements in methods used to establish such scales. Job-evaluation scales are based on five factors found in all mental and physical service and which in general scope include all possible difficulty values of any job. These factors are working requirement (including exposure to accident), physical requirement, skill requirement, responsibility requirement, and mental requirement. *The Iron Age*, October 10, 1946, Vol. 158, No. 15, pages 64–66, 4 illus.

Production Methods

Production Development. In a move to achieve closer coordination of design and manufacture, the Fairey Aviation Company, Ltd., is effecting a rearrangement of the drafting-office organization, an important part of which is the establishment of a production-development department. The result is to merge, to a great extent, a section of the jig and tool office with the design office so that consideration of production methods begins simultaneously with the commencement of work on a new design. The first steps in laying out the tools required are taken soon thereafter and well before the design itself has been completed. The basic principle of the plan calls for the closest cooperation between the design and production staffs. Among the benefits derived is the simplification of the assembly and the reduction of the number of parts. A typical example is found in the inter-spar ribs of the Spearfish, in which all reinforcement is obtained by the use of integral stiffeners and the whole rib is produced in one simple forming operation. The work is based on what is called a scheme sheet which represents a detailed breakdown of the main sequence drawing. Examples are given of the preparation and use of the scheme sheet and samples of typical sheets are reproduced. *Aircraft Production*, October, 1946, Vol. 8, No. 96, pages 479–481, 4 illus.

Spotwelding Technique for Primary Structures. Part I. Frederick S. Dever. Procedures followed by The Ryan Aeronautical Company in the spot welding of aircraft primary structures are described in a two-part serial article, of which this is the first installment. Following a reference to the growing value of spot welding for the aircraft industry, the writer analyzes pertinent structural design considerations and details the basic preparatory steps for this fabrication process. *Aviation*, October, 1946, Vol. 45, No. 10, pages 66–68, 5 illus.



Photograph Courtesy North American Aviation, Inc.

A cap assembly which illustrates a plug-type joint before furnace brazing *(left)* and after furnace brazing *(right)*. The inside of the joint can be visually inspected for copper penetration. (See "Copper Furnace Brazed Parts and Principles of Design.")

Pressure Gas Welding of Alloy Steel Tubing. J. L. Zambrow and R. D. Williams. An investigation was made of the factors that control the quality of oxyacetylene pressure welded joints in thick-walled, high-strength, alloy-steel tubing. All of the welding was done by the closed-joint method, in which the welding faces are in contact under pressure throughout the welding cycle. The first phase of the investigation involved the design and construction of the welding machine and auxiliary equipment. After these were functioning properly, various operational sequences, joint types, and protective coatings and atmospheres were investigated. In this way welding conditions were established which permitted the production of unre-enforced joints that were equivalent in strength to the parent metal, even when heat-treated to tensile strengths of 150,000 lbs. per sq.in. or higher, although the welding technique was not entirely satisfactory for the higher levels. Inability to produce consistently joints equal in strength to the parent metal was attributed chiefly to an oxidized zone of weakness at the weld plane. The results discussed in the paper indicate that strong joints equal to or superior to those made by other common welding processes can be obtained and that the process has considerable merit. *The Welding Journal*, October, 1946, Vol. 25, No. 10, pages 585-s–596-s, 19 illus.

Copper Furnace Brazed Parts and Principles of Design. Kenneth Schmidt. Information is provided regarding the design of aircraft parts to be fabricated by copper brazing. Design fundamentals are discussed and details are given about the placing of the copper and the degree of joint tighteners required for the best results. The importance of venting and types of vents is pointed out. The treatment of parts after brazing is described. Comparative data on costs are included. Charts show the relative strength of copper-brazed joints with several classes of fit, compared with the shear strengths of annealed low-carbon steel and of copper; and the ultimate shear strength of copper-brazed and heat-treated joints in carbon and alloy steels. *Product Engineering*, October, 1946, Vol. 17, No. 10, pages 103–107, 11 illus.

Forging Costs Cut by Improved Die Lubricant. Lambert R. Pistoles. An investigation was conducted at the propeller plant of the Curtiss-Wright Corporation with the object of finding a better lubricant for the surface of forging dies. The compound that was being used consisted of a mixture of a run-of-refinery oil and graphite but results were not satisfactory because the graphite settled to the bottom of the container and the die surfaces were coated with oil only. It was found that forging-die costs could be cut by the use of a low-viscosity volatile oil with a small percentage of a colloidal additive serving as the ve-

hicle for suspending the graphite and aiding in its dispersion on the tools and the forging blank. *The Iron Age*, October 17, 1946, Vol. 158, No. 16, pages 55, 56, 3 illus.

The Welding of Non-Ferrous Metals. Part VIII. E. G. West. The eighth section of a serial article on welding procedures as applied to the various nonferrous metals and alloys deals with the welding of copper and its alloys. The weldability of copper is discussed and the principal factors influencing welding procedure are enumerated. Possible causes of difficulty in the welding of copper are explained in some detail. Sections are devoted to the physical characteristics of the material, gas porosity, reactions with oxygen, changes during welding, the phenomenon of gassing, and the tendency of copper to crack when welded. *Sheet Metal Industries*, October, 1946, Vol. 23, No. 234, pages 1979–1984, 1990, 9 illus.

Effects of Corrosion on Spot Welded 75ST Alclad Alloy. Mario L. Ochieano. The results of tests conducted to determine the weld characteristics, welding technique, and corrosion aspects of 75 S-T aluminum alloy are reported. It was found that improper material preparation and welding techniques result in erratic bonding in the corona area of the spot welds. This nonuniform bonding is affected by salt spray, resulting in an inconsistent reduction in shear strengths. Data from tension specimens and data on the preparation and welding of specimens are presented and discussed. *Product Engineering*, October, 1946, Vol. 27, No. 10, pages 126–128, 6 illus.

Fabricating Patterns at AMI. DeForest L. Smith. In a brief nontechnical article the head of the pattern shop of Aircooled Motors, Inc., traces the steps required in the fabrication of patterns for casting the parts of aircooled aircraft engines. Taking as an example the crankcase of the Franklin 6AL-500 engine, he reviews the work of making the master pattern from wood, in which allowance must be made for shrinkage in the casting process in both the master metal mold and in the production castings made in it. In making the original layout the usual shrinkage allowance is $^5/_{32}$ in. to the foot. One-eighth in. per ft. is allowed for the master pattern and $^5/_{32}$ in. per ft. for the casting itself. Noting that the completion of a set of crankcase patterns calls for about 1,500 lbs. of pattern castings and about 4,000 man-hours of work, the writer proceeds to explain the processes of finishing the master patterns to exact dimensions, including the pattern for the outside of the case, ten main core boxes and several small ones that form the inside case, the making of the flow gates that control the flow of metal into the mold, and the careful inspection and quality-control methods that guard against defects in the finished castings. *Franklin Facts*, September, 1946, Vol. 9, No. 9, pages 1, 8, 2 illus.

Production Tools and Equipment

Profile Copying. A profile copying machine with optical control for contour milling direct from template layouts was developed by the German Messerschmitt organization. The machine differs from other machines designed for the same general purpose in that it is possible to copy a profile directly from a mold-loft or other template layout without the need for first making a three-dimensional model to serve as a master. The method of copying and the simple optical system are described. *Aircraft Production*, October, 1946, Vol. 8, No. 96, pages 482, 483, 2 illus.

Taper Form Grinding of Piston Skirts. Reference is made to difficulties that have been encountered in the commercial production of ideally shaped pistons for internal-combustion engines, that is, a shape that would overcome troubles caused by exhaustion and contraction. Details are given about the Scrivener piston-grinding machine, which has been developed in England to produce automatically pistons with an oval contour tapering to a true circle. *The Iron Age*, October 17, 1946, Vol. 158, No. 16, pages 56, 57, 5 illus.

Reconversion Tooling Problems. N. A. Lombard. The writer, a tooling engineer of Douglas Aircraft Company, Inc., compares the reconversion problems of the aircraft industry with those of other industries. It is pointed out that the aircraft industry faces the same problems as other industries together with additional ones which are outlined. Consideration then is given to the reduction, reassignment, and realignment of personnel, plant and machinery rearrangement, new tool requirements, and the process-planning problem. *Western Flying*, October, 1946, Vol. 26, No. 10, pages 27, 62, 64, 66, 2 illus.

Propellers

Investigation of the Effect of a Tip Modification and Thermal De-Icing Air Flow on Propeller Performance. Blake W. Corson, Jr., and Julian D. Maynard. Aerodynamic tests of a 12.208-ft.-diameter two-blade hollow steel propeller before and after alteration for thermal deicing have been made in the Langley 16-ft. high-speed tunnel to determine the effect of the alterations on propeller efficiency. The propeller, which had Clark Y blade sections, was tested on a 2,000-hp. dynamometer at blade angles ranging from about 25° to 60° at the 42-in. radius and at air speeds varying from 100 to 425 m.p.h.

The loss of propeller envelope efficiency due to the tip alteration without internal airflow amounted to about $1^1/_2$ per cent at the lower values of advance ratio and decreased to about $^1/_2$ per cent at an advance ratio of 2.8. The overall loss of propeller efficiency due to the tip alteration with internal airflow amounted to about 3 per cent at the lower values of advance ratio and decreased to about $^1/_2$ per cent at an advance ratio of 2.8. An increase in helical tip Mach Number from 0.75 to 0.88 had little or no effect on the loss of propeller efficiency caused by the internal airflow. The coefficient of mass flow of deicing air increased with propeller advance ratio and decreased with increase in rotational speed for the particular thermal deicing propeller used in the tests. *National Advisory Committee for Aeronautics, T.N. No. 1111*, July, 1946.

Analysis of Propeller Efficiency Losses Associated with Heated-Air Thermal De-Icing. Blake W. Corson, Jr., and Julian D. Maynard. The efficiency losses associated with heated-air thermal deicing were measured in tests of a two-blade hollow steel propeller in the Langley 16-ft. high-speed tunnel. The primary purpose of the tests was to make a quick determination of the efficiency loss due to internal airflow. For the available data, measured efficiency losses are compared with the calculated losses and the agreement is found to be within the experimental accuracy of the data. The change in propeller efficiency associated with heated-air thermal deicing can be attributed to two effects—namely, the effect of the tip nozzle on the airfoil characteristics of the blade sections in the vicinity of the nozzle, and the effect of the internal flow on the power absorbed and the net thrust produced by the propeller.

The method presented may be used with reasonable accuracy to determine the net change in propeller efficiency due to the combined effects of the nozzle and internal flow if the characteristics of the propeller without nozzles are known. The derived equations are correlated with the data presented in "Investigation of the Effect of a Tip Modification and Thermal De-Icing Air Flow on Propeller Performance," *T.N. No. 1111*, 1946. *National Advisory Committee for Aeronautics, T.N. No. 1112*, July, 1946.

M. V. P. Manually-Variable-Pitch Propellers. The operation of a post-war version of the de Havilland manually variable-pitch propeller for light aircraft is explained, with comments concerning the improvement in performance attained by various types of French and British airplanes following the installation of the propeller. The pitch of the blades is changed by a small handle which, through a flexible shaft, operates a worm gear in a box on the engine nose. By a nut-and-screw mechanism one of the races of a ball bearing is moved axially along the propeller shaft, and from the other race, which rotates with the propeller, links attached to the blade roots alter the pitch. Since the worm gear is irreversible, the blades lock in whatever position they are left, giving an infinite variety of fixed pitches within the range between the stops, which is 15° at present. It is stated that a propeller of that type installed

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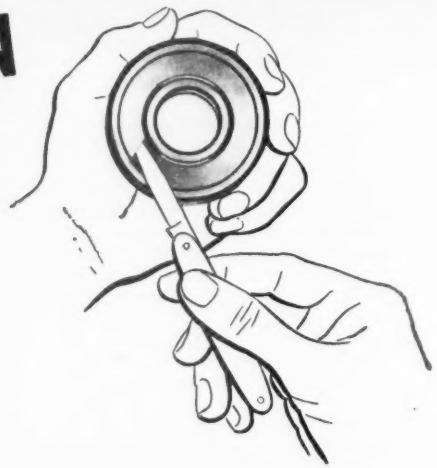

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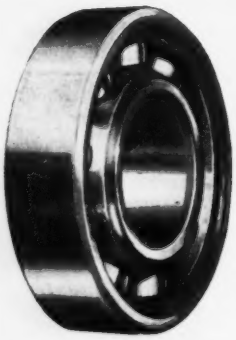

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on a French S.E.2-300 monoplane trainer showed a 20 to 25 per cent reduction in take-off run, and improvement averaging 20 per cent in rate of climb to 10,000 ft. A twin-engined Dragon Rapide, loaded to 5,800 lbs., having a small electric motor to drive the pitch-change mechanism of both propellers, gave estimated performance improvements including the reduction of take-off distance from 380 to 260 yards, a cruising-speed increase from 124 m.p.h. at sea level to 141 m.p.h. at 6,000 ft., and considerable betterment in single-engine performance. Other advantages for commercial and private operators are outlined. *de Havilland Gazette*, August, 1946, No. 34, pages 8, 9, 4 illus.

Radar

Multi-Purpose Airport Radar. The Bendix Airport Surveillance System was developed for the U.S. Navy Department for use as an auxiliary to the Ground Controlled Approach (G.C.A.) and also as an independent airport search system to aid in traffic control. The equipment, designated as Radio Set AN/GPN-2, has been made available by the Bureau of Ships. It gives complete radar coverage of the sky within 30 nautical miles of the equipment, up to more than 10,000 ft., and includes two-way radio communications equipment operable on all aircraft frequencies. A single operator can detect, locate, and control all aircraft within the service area; he can guide them in heavy weather, arrange traffic or landing patterns, and direct pilots to the correct approach path for landing. Provision is made for a second plotting or liaison operator under heavy traffic conditions. No equipment is required in the plane except ordinary communications equipment.

The cathode-ray indicator presents a circular map, 10 in. in diameter, of the surrounding area and provides ranges of 6, 10, 20, and 30 nautical miles at the turn of a switch. This large indicator, coupled with the performance of the radar, gives a brilliant image having clarity and definition. New circuit features, including fast time constant circuits, reduce the masking effect of ground clutter on the tube, making easier the tracking of moving targets quite close to the ground. *Bendix Aviation Corporation.*

Rotating Wing Aircraft

Practical Engineering of Rotary Wing Aircraft. Paul H. Stanley. Continuing a discussion on design criteria for rotating wing aircraft, the Chief Engineer of the Autogiro Company of America investigates the problem of obtaining satisfactory balance and stability. He commences with the fundamentals for the determination of correct balance and stability as obtained from tests and analyses of early autogiros and then gives details regarding the application of the concepts to the latest types of rotating wing aircraft. *Aviation*, October, 1946, Vol. 45, No. 10, pages 74–77, 6 illus.

Controls and Types of Rotor Craft. Raoul Hafner. Fundamental principles of controlled flight in fixed-wing aircraft are outlined. Consideration then is given to flight control in the helicopter. It is explained that the helicopter differs from the fixed-wing aircraft in that it is not forced to fly in the direction in which its nose points. An airplane that possesses rudder and aileron control can divorce rotational from translational movement. The helicopter in slow flight can move in any direction in space, without noticeable change of attitude relative to the ground. This additional freedom of movement would not be possible without the addition of a height control. It is also noted that the other controls of the helicopter are analogous to the respective controls in a fixed-wing aircraft but are not quite identical in operation. The reasons for this are explained. Various methods of meeting the special control requirements of the helicopter are discussed. The advantages and disadvantages of different rotor designs are considered. *American Helicopter*, November, 1946, Vol. 4, No. 12, pages 18–20, 46, 4 illus.

German Jet-Propulsion Helicopter. A German helicopter utilizing the principles of jet propulsion is undergoing analysis by Technical Intelligence of the Air Matériel Command at Wright Field. It is the WNF-342-V-4, built by Friedrich Doblhoff in Austria, and is the fourth and last in a series of experimental helicopters built by that constructor. The first two models were never flown; the third, the one-place V-3, crashed, and with modifications became the two-place V-4.

The rotor blades are revolved by the gas from a jet engine piped to the blade terminals. In this way the aircraft can hover or go up and down. Forward speed is attained by tipping the tail elevators. A pusher propeller at the rear of the fuselage provides a slipstream, allowing easier directional control. This is powered by a small engine that is carried in addition to the jet engine. Neither engine directly propels the V-4.

Using only the tail elevator, the V-4 cruises at speeds up to 25 m.p.h. Air Intelligence members believe this speed can be greatly increased by the addition of another propeller to provide forward thrust. Experiments are now being conducted along these lines. *Army Air Forces, Air Matériel Command.*

The G-E Gyro-Glider. A wingless craft that works like an autogiro without a power source has been developed at the General Electric Flight Test Center and is known as the G-E Gyro-Glider. The craft is flown with the aid of two 9-ft. rotating blades atop it. Weighing 120 lbs., it is capable of lifting nearly 300 lbs. in addition to its own weight.

The Gyro-Glider can land in extremely small areas, requiring a landing field of not more than 60 ft. in diameter. It is expected to have wide commercial application as a means of reaching isolated areas that are not provided with adequate landing fields. The weight of the glider is one-third that of a standard fixed-wing glider, and it can be steered within limited range and landed on any spot selected by the pilot.

The new aircraft, which can be towed by airplane and released from various altitudes like a standard glider, is reported to have a descending speed less than that of a parachute. It can be landed with such ease that it is not likely that damage will be caused to the cargo. Like an autogiro,

The General Electric gyro-glider is capable of lifting nearly 300 lbs. in addition to its own weight and can land in extremely small areas. (See "The G-E Gyro-Glider.")

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- Elastic Mareng fuel tanks . . . bird-proof windshield . . . thermal anti-icing . . . under-wing pressure fueling . . . bomb-bay type maintenance hatches.
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- Operational range, maximum (7300 lbs. of fuel) 1,790 mi.
- Rate of climb at sea level (take-off weight, normal power) 1,250 ft. per min. Operates with great efficiency at any altitude required to fly above mountainous terrain of west.
- With Martin 2-0-2 and 3-0-3 standard for airlines, cargo operators will obtain better service and maintenance . . . cheaper, more readily available, spare parts.

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the new glider makes a forward roll of 20 to 30 ft. when landing. The rotating blades, with a total diameter of 18 ft., can be removed easily so that the Gyro-Glider can be transported from home to airport in the rear of a station wagon, which also can serve as towing agent. The new craft is equipped with a tricycle landing gear, which enables the pilot to steer it within a limited range on the ground.

In experimental flights a tow rope allows the craft to reach an altitude of more than 100 ft., but one of the designers claims that the new craft can be flown at any altitude now obtainable with a standard glider. *General Electric Company.*

Stress Analysis and Structures

Determination and Presentation of Compressive Stress-Strain Data for Thin Sheet Metal. Walter Ramberg and James A. Miller. Various methods of obtaining the compressive stress-strain curve of thin sheet metal are described, and their advantages and limitations are briefly discussed. The presentation of stress-strain data in dimensionless form is outlined, and the advantages of such a presentation in correcting for the effect of variations in yield strength and in Young's modulus are pointed out. Attention is called to a classification of stress-strain curves by shape factors following a three-parameter formula proposed by Osgood. *Journal of the Aeronautical Sciences,* November, 1946, Vol. 13, No. 11, pages 569–580, 15 illus.

The Effect of Radius of Curvature and Preliminary Artificial Eccentricities on Buckling Loads of Curved Thin Aluminum-Alloy Sheets for Monocoque Constructions. Georges Welter. In two previous papers the results of tests on thin curved aluminum-alloy sheets in compression were presented. The present paper, the publication of which was restricted during the war, shows that sheets of aluminum alloy tested under special conditions offer highly increased buckling and ultimate strengths under compression loads. By decreasing the radius of cold-rolled curved sheets 40 to 50 per cent, a much greater ultimate buckling load can be obtained if these panels are tested under the usual radius of curvature (24 in.). Buckling and ultimate loads are distinctly higher, the usual buckling loads being exceeded by about 100 per cent.

Local eccentricities of the curved panels, generally assumed to be exceedingly detrimental to the bearing capacity in compression, did not decrease the buckling load of the panels. Even holes produced by shooting bullets through the panels did not weaken materially their normal buckling strength or their ultimate resistance. *Journal of the Aeronautical Sciences,* November, 1946, Vol. 13, No. 11, pages 593–596, 604, 5 illus.

Higher Modes of Vibration by a Method of Sweeping. L. Beskin and R. M. Rosenberg. A method is presented whereby the frequencies and deflection curves in bending and torsional vibrations of continuous beams of variable section can be found. Emphasis is placed on the determination of modes higher than the first. This method was developed in an effort to use the Stodola iteration process in the determination of higher modes of vibration. One of the most important advantages of the method presented here is that its application does not require unfamiliar tools of mathematics such as matrix techniques. Therefore, actual calculations may be reduced to a routine that may be entrusted to computers having a high-school background only. This paper, containing a numerical example worked out in detail, was written in such a manner as to emphasize application rather than veil it.

In applying the method, it is necessary to determine the first $(n - 1)$ modes. The nth mode is then found in the following manner:

(1) A "reasonable" estimate (as defined in the body of the paper) of the nth mode is made.
(2) The preceding $(n - 1)$ modes are cleared from the estimated nth mode by a method of sweeping.
(3) The swept mode is operated on with Stodola's iteration method leading to convergence to the nth mode.

For great accuracy, alternate sweeping operations and Stodola iterations are continued leading to an indefinitely close approximation of the nth mode. This method has been used by the writers with excellent results and presents the best compromise between simplicity, accuracy, and reduction of labor known to them. *Journal of the Aeronautical Sciences,* November, 1946, Vol. 13, No. 11, pages 597–603, 4 illus.

Vibrations of a Helicopter on the Ground. Gabriel Horvay. The present paper serves as an introduction to ground vibration analysis. Considerable insight may be gained into the phenomenon of ground vibrations, without actually going into the analysis of these somewhat complicated self-excited oscillations, by limiting one's attention to the much simpler problem—that of forced vibrations of the helicopter, on the ground with the blade hinges locked. This preliminary study permits the determination of the natural modes of the helicopter, the ratios of the various amplitudes at resonance, and the magnitudes of the oscillations and of the blade unbalance forces at which shock-strut action sets in. The connection between the present study and ground vibration analysis is also taken up briefly, and a numerical example is given. Finally, the spring and damping constants of a tire-shock-strut combination are determined, and a discussion is given of the various constants of the shock absorber which play a role in ground vibrations. *Journal of the Aeronautical Sciences,* November, 1946, Vol. 13, No. 11, pages 605–619, 18 illus.

Theory for Axial Rigidity of Structural Members Having Ovaloid or Square Perforations. Martin Greenspan. This is an extension of a previous paper in which the writer demonstrated a method for computing the axial rigidity of a tension or compression member having a uniform gross cross section and a series of similar perforations of circular or elliptical shape uniformly distributed along the length. The method is extended to other shapes of perforation. Formulas are derived for computing the overall lengthening or shortening of such a member when the series of similar perforations are of approximately ovaloid or approximately square shape. *Journal of Research of the National Bureau of Standards,* September, 1946, Vol. 37, No. 3, pages 157–161, 2 illus.

Stresses by Analysis and Experiment. A. J. Sutton Pippard. An attempt is made to outline in a single paper the bases of structural analysis when stresses do not exceed the limit of proportionality. The fundamental theorems are stated and the general problems in the analysis of just-stiff and redundant frameworks are discussed. The solution of a just-stiff frame is obtained when a compatible system of stresses is determined, but this is insufficient if the structure be redundant; the strains must then also be compatible. Passing reference is made to the best-known methods of stressing just-stiff frames—the stress diagram and method of sections—but the method of tension coefficients is described in rather more detail with reference to the elementary space frame.

The classical methods of dealing with redundant frames are next outlined. After a reference to slope-deflection analysis, of which an early example was Clapeyron's treatment of the continuous beam (the theorem of three moments), the work of Castigliano is considered and in illustration his second theorem is used to obtain the stresses in a flywheel due to the heating of the rim by a brake. A most important contribution to the treatment of redundant structures was made in 1930 when Prof. Hardy Cross described his moment distribution method. This is illustrated by an example and reference is made to the powerful relaxation methods developed by Prof. R. V. Southwell. The paper concludes with a short description of an experimental method for obtaining influence lines and of another for the solution of certain problems of

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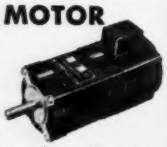

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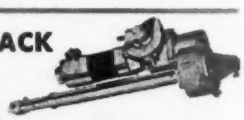

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plane stress analysis. *Proceedings of the Institution of Mechanical Engineers*, 1946, Vol. 155, No. 13, pages 20–28, 14 illus.

Poisson's Ratio of Some Structural Alloys for Large Strains. Ambrose H. Stang, Martin Greenspan, and Sanford B. Newman. A report is given of an investigation of the elastic and plastic properties of some structural alloys under simple tension, with particular reference to the variation of Poisson's ratio with axial strain for large strains. The investigation was carried out by the National Bureau of Standards in cooperation with the Air Matériel Command. Values of Poisson's ratio, as well as ordinary stress-strain properties, for tensile strains as high as 18 per cent, were determined on sheets of aluminum alloys 24S-T and 24S-RT, chrome-molybdenum steel plate, and structural and fully killed low-carbon steel plate. The results of the investigation are summarized and discussed. *Journal of Research of the National Bureau of Standards*, October, 1946, Vol. 37, No. 4, pages 211–221, 21 illus.

Investigation of the Behavior of Thin-Walled Panels with Cutouts. (Report No. 454 of the Central Aero-Hydrodynamical Institute, Moscow, 1939.) A. A. Podorszhny. The paper deals with the computation and methods of reinforcement of stiffened panels with cutouts under bending loads such as are applied to the sides of a fuselage. A comparison is made between the computed and test results. Results also are presented of tests on panels with cutouts under tensile and compressive loads. *National Advisory Committee for Aeronautics, T.M. No. 1094*, September, 1946.

The Lagrangian Multiplier Method of Finding Upper and Lower Limits to Critical Stresses of Clamped Plates. Bernard Budiansky and Pai C. Hu. The theory of Lagrangian multipliers is applied to the problem of finding both upper and lower limits to the true compressive buckling stress of a clamped rectangular plate. The upper and lower limits thus bracket the true stress, which cannot be exactly found by the differential-equation approach.

The procedure for obtaining the upper limit, which is believed to be new, presents certain advantages over the classical Rayleigh-Ritz method of finding upper limits. The theory of the lower-limit procedure has been given by E. Trefftz but, in the present application, the method differs from that of Trefftz in a way that makes it inherently more quickly convergent. It is expected that in other buckling problems and in some vibration problems the Lagrangian multiplier method of finding upper and lower limits may be advantageously applied to the calculation of buckling stresses and natural frequencies. *National Advisory Committee for Aeronautics, T.N. No. 1103*, July, 1946.

Flexure-Torsion Flutter Derivatives for Semi-Rigid Wings. R. A. Frazer. A method is described for the estimation of the air forces on oscillating semirigid wings having any number of flexural-torsional degrees of freedom. The nondimensional coefficients that are actually introduced are referred to for definiteness as the "air-load coefficients," and they are all readily expressible as linear combinations of the usual nondimensional derivative coefficients. The scheme of calculation involves no novel principle and is merely a form of strip theory based on air-load coefficients calculated by the vortex-sheet theory for two-dimensional motion. In the integrations over the span account is taken of the grading of the frequency parameter and of the displacements, so that partial allowance is made for the actual three-dimensional conditions of flow.

For the sake of completeness, the paper commences with a brief statement of the generalized theory of flexure-torsion flutter. Preliminary approximations for the theoretic two-dimensional air-load coefficients are obtained in the form of polynomials, and these approximations are used to construct tables of integrals which greatly assist the calculations for straight-tapered wings. To illustrate the use of these tables, the actual air-load coefficients are obtained for wings with representative simple modes of displacement and various degrees of taper.

The critical speeds for a tapered model wing tested for flutter and divergence by Jones and Lambourne are calculated with the use of air-load coefficients obtained in the fifth section of the paper. The observed and predicted speeds are compared. The divergence speeds are in good agreement, but the predicted critical speeds for flutter are considerably less than the observed speeds. One possible explanation of the discrepancy is that the calculations make no allowance for the internal friction of the wing, which would have an important stabilizing effect at the extremely low air speed used for the tests. Moreover, the vortex-sheet theory can hardly be expected to apply satisfactorily at low speeds. It is noted that comparisons with wind-tunnel tests carried out at much higher speeds would be valuable. *British Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1942*. British Information Services, New York, $1.35.

A Comparison of the Observed and Predicted Flexure-Torsion Flutter Characteristics of a Tapered Model Wing. R. A. Frazer and Sylvia W. Skan. Critical speeds and critical frequencies for flexure-torsion flutter of a tapered model wing have been measured in a wind tunnel by Jones and Lambourne. The stiffness-ratio parameter covered the range 1.5 to 17.5 in the tests. In the present paper these experimental results are compared with the flutter characteristics predicted for the wing by the strip-theory method developed in *R. & M. No. 1942*. The principal formulas required are summarized and certain difficulties connected with accuracy in the calculation of the air forces appropriate to large values of the frequency parameter are explained. The actual predictions for the model wing are described and the results are given in tables and graphs.

From one of the graphs it is seen that over the practical range of stiffness-ratio parameter the calculated and observed critical speeds accord satisfactorily, but that the theoretic results are extremely sensitive to small variations of the damping coefficients for larger values. This sensitivity is because of the fact that with the particular model wing investigated the discriminant of the dissipation function tends to become extremely small. The predicted and observed critical frequencies are seen from another graph to be in excellent agreement throughout the complete range of 1.5 to 17.5. *British Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1943*. British Information Services, New York, $0.75.

Note on the Transformation Formulae for Derivatives of a Semi-Rigid Wing. R. A. Frazer. Confusion is sometimes apt to arise in the interpretation of transformation formulas for aerodynamical derivatives of flexible wings. In some cases this is because of obscurities in the definitions of the derivatives themselves, and in others because of the usage of the term "reference center" in two distinct senses. These questions are briefly reviewed. Definitions are given for "wing reference center" or "reference point," and the parameters that influence the derivatives are discussed. Formulas are developed for the necessary calculations and the conditions under which they are applicable are explained. *British Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1949*. British Information Services, New York, $0.40.

Methods of Predicting Flexure-Torsion Flutter of Cantilever Wings. J. Williams. It is assumed that, for the purposes of flexure-torsion analysis, the cantilever wing may be treated as a semirigid body possessing two degrees of freedom. Part I of the report, "Comparison of Methods by Inertia-Stiffness Diagrams," describes six methods for the prediction of critical flexure-torsion flutter speeds of such a wing. The methods are compared by use of the inertia-stiffness diagram, which allows the two moments of inertia and the two elastic stiffnesses to be left free for choice. The numerical calculations carried out are explained and the principal conclusions are summarized.

Part II, "The Two-Dimensional Classical Formula," develops a formula such that when the structural mass and plan-form data, together with the fundamental resonance fre-

William "Bill" Ong (left), President, ONG AIRCRAFT CORPORATION, Kansas City, Missouri—Kansas and Missouri Distributors for REPUBLIC AVIATION CORPORATION—takes delivery of the first of 150 Seabees he has on order, from Gordon Sleeper, Sales Manager, Personal Plane Division of Republic.

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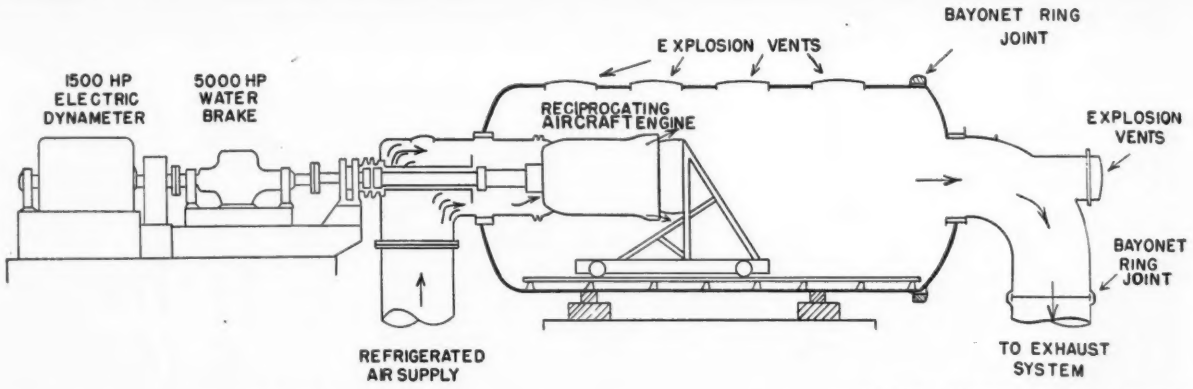

Illustration Courtesy General Electric Company

Schematic diagram of altitude-test chamber for reciprocating engines, at Bavarian Motor Works in Germany. (See "Bavarian Motor Works Altitude-Test Facilities.")

quencies, are available for a specific cantilever wing the lowest critical flutter speed of that wing can be calculated directly from the formula. *British Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1990.* British Information Services, New York, $1.65.

The Effect of Openings on the Torsional Stiffness of Rectangular Section Tubes. H. J. Allwright. It has been shown by D. Williams in an article titled "Openings in Stressed Skin Wings," that holes or gaps in the cover skin of a stressed skin wing may cause considerably increased stresses; it was desired to obtain quantitative information on the corresponding reduction in torsional stiffness. Following the analysis given by Williams, an expression is derived for the torsional stiffness of a rectangular section tube with an opening through the upper and lower cover skins, when a concentrated torque is applied at an intermediate section outboard of the opening. This stiffness is compared with the stiffness of a similar tube with no opening, and the effects of varying the length and position of the opening and of varying the flange area of the spars are examined for a torque applied at the three-quarter span section. Openings such as are necessary for fuel tanks and retractable landing gears may cause serious losses of torsional stiffness and should be made as short as possible in a spanwise direction. An opening of given dimensions results in least loss of stiffness when near the wing root, but it then causes larger local stresses than if positioned out along the span. Increase of spar flange area above that necessary for flexural strength has little effect in reducing the loss of torsional stiffness. *British Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1993.* British Information Services, New York, $0.60.

Wind Tunnels and Laboratories

Bavarian Motor Works Altitude-Test Facilities. E. E. Stoeckly. A considerably detailed description is given of the equipment and operation of the high-altitude, low-temperature, aircraft-engine test chamber at the Bavarian Motor Works in Germany. The history of the development of this test chamber is reviewed. Details are given about the air compressor, air-cooling system, air-exhaust system, and other plant equipment. Schematic diagrams of altitude-test chambers for reciprocating and jet engines show the layout of the equipment. *Transactions of the A.S.M.E.*, October, 1946, Vol. 68, No. 7, pages 743–750, 20 illus.

Miscellaneous

Launching Aircraft Electrically. M. F. Jones. A device for assisting the take-off of airplanes from the ground is essentially a linear electric motor having a low inertia characteristic. Named the Electropult, this electric catapult was developed for the Navy by Westinghouse Electric Corporation. The linear motor is similar electrically to the ordinary rotating induction motor except that it is flat instead of circular, the secondary winding being stretched out in the form of a track and the primary windings being mounted on a shuttle car. The shuttle car is attached to the airplane by a detachable steel towing cable, and when the motor is energized the airplane is catapulted into the air at flying speed within a space of about 500 ft. In one of the Electropults, installed at the Naval Air Test Center, Patuxent River, Md., the shuttle car weighs 4,600 lbs. and exerts a tractive force of 17,000 lbs., developing 10,000 hp. at 220 m.p.h. It is able to launch the largest current naval aircraft except the Martin Mars type. Power is supplied by a Pratt & Whitney Double Wasp engine operating through an electric drive and a heavy flywheel and motor-generator unit that stores kinetic energy for the short-time peak load of moving the shuttle car. Other electrical apparatus provides the necessary controls for the shuttle car to bring it to a stop at the end of the run and return it to the starting point. The article gives a detailed description of the device and its equipment and operation. The possibility of employing the device at commercial airports and for aircraft-carrier or other water-based operations is stated to depend upon the development of landing equipment to match the take-off performance. *Aviation*, October, 1946, Vol. 45, No. 10, pages 62–65, 4 illus.

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When this Bell Laboratories chemist turns the stop-cock he raises a column of mercury to trap a micro-sample of gas evolved from a specimen of copper. Later he will analyze the sample by micro-techniques.

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Books

All of the books reviewed and listed are in the I.A.S. Library and may be borrowed without charge, except for certain reference books. Application for loans should be made to The Paul Kollsman Lending Library, 2 East 64th Street, New York 21, N.Y.

Air Transport At War, by Reginald M. Cleveland. N.Y., Harper & Bros., 1946. 324 p. $3.50.

On the first page of this book President Roosevelt tears up an executive order just signed, calling for the commandeering of United States flag air lines by the armed forces. He did so after listening to the joint plea of Gen. Henry H. Arnold, chief of the Army Air Forces, and Col. Edgar S. Gorrell, President of the Air Transport Association. On the last page of the book is a table of statistics of contract operations of the air lines, the Army Air Transport Command, and the Naval Air Transport Service. Between these pages, Mr. Cleveland gives a closely packed account of the part played by the air lines in the war, from the first plan for cooperation with the armed forces made in 1936, to the final victory. Official records, published sources, and his own wide knowledge of air transport are drawn upon to create an integrated story that contributes not only to the history of the war, but also to an understanding of the rapid development of air transport in the last decade. There is much in the book about personalities who made the success of air-transport operations possible, and the technical contributions of the air lines are given due credit. The importance of the early liquidation of Axis air lines in Latin America is stated by the author, but his award of the credit for this principally to the commercial air lines does not take all the evidence into account. The struggle for airways in Latin America was a cooperative effort of the commercial air lines and governments in the Americas, including certainly our own. The importance to national security of a strong air-transport industry is once again demonstrated in this account of achievement, and in a readable and useful fashion.

Aerodynamics, by A. Wiley Sherwood. N.Y., McGraw-Hill Book Co., Inc., 1946. 220 p. $2.75.

The aim of this textbook is to provide a general practical background in both theory and experiment for later, more intensive mathematical work in aerodynamics. Dimensional analysis and dynamic similarity are introduced early in the book. The chapter on experimental methods is the longest in the book and includes wind-tunnel corrections. The more advanced subject of compressibility is included in a separate chapter, and flutter is included in the discussion on control surfaces. There is a final chapter on unconventional aircraft, including the helicopter, more briefly the autogiro, and jet propulsion and rocket motors. A knowledge of calculus is not essential for use of the book but previous work in physics and mechanics is helpful. The author is a professor of aerodynamics at the University of Maryland. The book can be recommended as an introductory text for theoretic aerodynamics.

Aircraft Carburetion, by Robert H. Thorner. N.Y., John Wiley & Sons, Inc., 1946. 393 p. $3.50.

Concerned with the fundamental principles, flight operation, and testing of aircraft carburetors, this book grew out of a series of lectures given by the author in engineering defense courses conducted by the University of Michigan in 1942. In order to present a concise and uninterrupted discussion about aircraft carburetor operating principles, he has omitted maintenance, overhaul, and design considerations. Equipment related to the carburetor, such as the fuel pump and the supercharger, is included in the treatment to complete the picture of the carburetor as an integral part of the power plant. In the section on flight operation, special attention is given to fuel economy. Descriptions of float, Holley, Stromberg injection, and Chandler-Evans carburetors are given in one section, followed by a comparison of these types. The author has realized his aims of presenting a discussion of the principles of carburetion and of simplifying available material on the principles of flight operation which apply to carburetors. The book fills a gap in the literature and should be useful to pilots, flight engineers, mechanics, and service and development engineers.

Airports: Design, Construction and Management, by Horace K. Glidden, Hervey F. Law, and John E. Cowles. N.Y., McGraw-Hill Book Co., Inc., 1946. 583 p., illus. $7.00.

Airport Planning, by Charles Froesch and Walter Prokosch. N.Y., John Wiley & Sons, Inc., 1946. 250 p., illus. $7.00.

6th Annual Airport Reference. (1946–1947). Los Angeles, Calif., Occidental Publishing Co., 1946. 104 p., illus. $2.00.

The Airport Directory. 1946. N.Y., The Haire Publishing Co., 1946. 599 p., illus. $3.00.

More than half of the book by Glidden, Law, and Cowles consists of specifications, test procedures, and drawings useful to the engineer in the planning and construction of an airport. The collection of these into one place is one of the principal features of this book, which is designed to provide procedures and guides for solving the problems encountered in airport design, construction, and management. The authors have been connected with airport activities of the First Region of the Civil Aeronautics Administration, which included the design and operation of the Washington National Airport. Chapters on traffic, control towers, radio aids, and communications have been included to complete the treatment of the functional aspects of an airport. Most of the 31 appendixes are specifications for various types of surfacing. The drawings and illustrations are in a separate section following the index.

The book by Froesch and Prokosch, chief engineer and architect, respectively, of Eastern Air Lines, Inc., originated as a pamphlet replying to questions raised by communities interested in airport planning and design Its larger page is more suitable for the reproduction of drawings and illustrations, which are integrated with the text instead of being placed in a separate section. A feature of the book is its emphasis on the characteristics of aircraft as a controlling factor in the planning and design of airports. The chapter on services details methods and equipment for fueling, fire protection, snow removal, and air conditioning in contrast to the overall

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consideration of management in the Glidden book. Although there is naturally some duplication in these two books, the book by Glidden, *et. al.*, is intended primarily for the engineer who will supplement it with standard engineering handbooks and the Froesch-Prokosch book seeks primarily to appraise functional factors rather than to explore specific detail design.

The 6th annual issue of the *Airport Reference* has brief chapters on airport planning, surfaces, lighting, buildings, communications, and administration. Directory and catalog information of airport equipment products, a brief directory of American and foreign civil aeronautics offices, a list of American aircraft in use, with storage classifications, a short bibliography, and a brief discussion of airport legal problems are included. This is a useful, inexpensive yearbook.

About three-fifths of the new edition of *The Airport Directory* lists the airports, seaplane bases, and anchorages in the United States. The information includes exact location, ownership, landing facilities, services, including size of hangars and doors, and accommodations, including taxi, bus, and connecting air-line service for each airport. The aviation industry *Red Book* section, a directory of products of interest to aeronautical manufacturers, occupies 160 pages. Directories of aircraft service operators, state aviation boards and commissions, radio range stations, and aircraft-engine, propeller, and rotary wing aircraft manufacturers are included with other useful features. This is a convenient and reasonably priced annual reference book.

Aérodynamique Experimentale (Experimental Aerodynamics), by Pierre Rebuffet. Paris, Librairie Polytechnique Ch. Beranger, 1945. 502 p., illus., diagrs.

The author, an engineer with the French Air Ministry, has put in book form the material developed from courses taught since 1942 at the École Nationale Superieure de l'Aéronautique. Many topics usually mentioned only briefly are here included in great detail; for example, 23 pages are devoted to the discussion of boundary layer on flat plates. The section on wind tunnels, sufficiently complete to be of value in itself as a text on the subject, treats separately the history, principles, special types, relative data, and the supersonic, and occupies 70 pages. The book is divided into nine main divisions, namely: Properties of Fluids, Phenomena and General Principles, Wind Tunnels, Experimental Measurement and Observation, Simple Geometric Bodies, Wing, Propeller, Airplane, and Rotating Wings. The closing pages of the division covering the Wing are devoted to subsonic and supersonic matters. Wind-Tunnel investigation is the basis for the discussions rather than experimental flight since, as the author explains, where flight is concerned, the field of investigation is limited by the actual conditions. The wind tunnels referred to are those both in France and abroad, particularly those in the United States engaged in propeller research. Good explanatory diagrams are freely used. A limitation is imposed by the absence of an index but the reader is guided by the detailed table of contents. A short general bibliography at the end of the volume supplements the bibliographic footnotes.

Mécanique des Fluides Théorique (Theoretical Fluid Mechanics), by Maurice Giqueaux. Paris, Librairie Polytechnique Ch. Beranger, 1944. 352 p. 290 fr.

Directed to engineers rather than to mathematicians, this work presupposes a minimum of mathematical knowledge. The word "theoretical" in the title is to be taken literally since there are only a few references to experimental methods and results, and the author explains that his work must be complemented by other texts stressing the experimental aspect. The scope is general and not limited to the aeronautical, to enable the reader to find at least some treatment of any subject he is likely to look up. The subjects treated in greater detail are laminar boundary layer, theory of turbulence of propellers, and compressible fluids. Other subjects are touched upon only lightly, such as turbulent flow, friction, the float gear and viscous fluids. Except for those dealing with the vortex theory of wings and propellers, almost all the problems discussed concern laminar flow. As in many French texts, there is no index but instead the table of contents bears many numbered subdivisions corresponding to numbered sections within the text. A bibliography of 41 items is included, together with biographic notes about the principal authors mentioned.

U.S. Strategic Bombing Survey. Over-all report. (European war.) Sept. 30, 1945. (Washington, Govt. Print. Off., 1945.) 109 p. Charts, maps, graphs.

Summary report, September 30, 1945, 18 p.

Aircraft division industry report. Strategic bombing of the German aircraft industry, Nov. 2, 1945. 124 p.

Aircraft division. Air frames plant reports.

No. 1. **Junkerflugzeug und motorenwerke,** Dessau, Sept. 26, 1945. 17 p.

No. 2. **Erla maschinenwerke g.m.b.h.,** Leipzig, Oct. 9, 1945. 10 p.

No. 3. **A T G maschinenbau g.m.b.h.,** Leipzig, Sept. 28, 1945. 15 p.

No. 4. **Gothaer waggonfabrik a.g.,** Gotha, Oct. 2, 1945. 14 p.

No. 5. **Focke-Wulf flugzeugbau g.m.b.h.,** Bremen, Sept. 26, 1945. 16 p.

No. 6. **Messerschmidt a.g.,** Augsburg, Oct. 24, 1945. 18 p.

No. 7. **Dornier werke g.m.b.h.,** Friedrichshafen and Munich, Oct. 1, 1945. 14 p.

No. 8. **Gerhard Fiesler werke g.m.b.h.,** Kassel, Oct. 15, 1945. 8 p.

No. 9. **Wiener Neustadter flugzeugwerke a.g.** (and subsidiaries), Wiener Neustadt, Austria, Sept. 28, 1945. 15 p.

Aircraft division. Aero engine plant reports.

No. 1. **Büssing NAG flugmotorenwerke g.m.b.h.,** Brunswick, Sept. 12, 1945. 12 p.

No. 2. **Mitteldeutsche motorenwerke g.m.b.h.,** Taucha (near Leipzig), Oct. 1, 1945. 10 p.

No. 3. **Bayerische motorenwerke a.g.,** Eisenach and Durrerhot, Oct. 17, 1945. 13 p.

No. 4. **Bayerische motorenwerke a.g.,** Munich, Oct. 22, 1945. 12 p.

No. 5. **Henschel flugmotorenwerke,** Kassel, Sept. 14, 1945. 7 p.

Aircraft division. The light metal industry of Germany. Part I. Aluminum. Part II. Magnesium. November 2, 1945. 38 p.

Aircraft division. Light metals plant reports.

No. 2. **Metalgussgesellschaft, m.b.h.,** Leipzig, Sept. 7, 1945. 13 p.

No. 3. **Aluminiumwerk g.m.b.h., Plant No. 2,** Bitterfeld, Sept. 14, 1945. 9 p.

No. 4. **Gebrüder Giulini g.m.b.h.,** Ludwigshafen-am-Rhein, 1945. 10 p.

No. 5. **Luftschiffbau Zeppelin g.m.b.h.,** Friedrichshafen, Sept. 20, 1945. 17 p.

No. 6. **Wieland werke a.g.,** Ulm-am-Donau, Sept. 20, 1945. 9 p.

No. 7. **Rudolph Rautenbach leichtmetall-giessereien,** Solingen, Sept. 22, 1945. 10 p.

No. 8. **Lippewerke, vereinigte aluminiumwerke a.g.,** Lunen, Sept. 11, 1945. 10 p.

No. 9. **Vereinigte deutsche metallwerke,** Hedderuheim, Oct. 2, 1945. 14 p.

No. 10. **Dürener metallwerke a.g.,** Plants at Duren, Wittenau-Berlin, Waren, Sept. 26, 1945. 8 p.

Morale division. The effect of bombing on health and medical care in Germany. Medical branch report. Oct. 30, 1945. Washington, D.C., War Department, 1945. 388 p.

Overall economics division. The effects of strategic bombing on the German war economy. Oct. 31, 1945. (Washington, Govt. Print. Off., 1945.) 286 p.

Overall economic effects division. (Report.) The gross national product of Germany, 1936–1944; Kriegseilbericht (War express report); the effects of strategic bombing upon the operations of the Hermann Goering works during World War II; Food and agriculture. 1945. 114 p.

Transportation division. The effects of strategic bombing on German transportation. Nov. 20, 1945. 90 p.

The systematic evaluation of the effect of strategic bombing upon the conduct of the war by Germany and upon the efficiency and social aspects of her economy in wartime had, of course, little precedent. The U.S. Strategic Bombing Survey was established in September, 1944, by a presidential directive, to analyze and

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report on the effect of the strategic aerial offensive. Early in 1945 its organization in England had been accomplished, and teams of specialists from the United States and the ETO were studying all the available intelligence on targets selected for survey and assigned to them, before going into the field. The field work on individual targets was completed early in the summer. A special group prepared an overall report on the aircraft industry of Germany, including aircraft, engine and accessory plants, and the light metal industry. Reports were in first draft form by August. The London office of the survey was closed in September and the reports were completed in Washington. The overall report and a summary report were published September 30, 1945.

The Aircraft Division was headed by T. P. Wright, formerly Director of the Aircraft Resources Control Office of the War Production Board and now Administrator of Civil Aeronautics. Since Mr. Wright could not give his full attention to the organization in Europe, he requested the services of Lt. Comdr. S. Paul Johnston (now Captain, U.S.N.R.), then stationed with the NATS in Honolulu, as his deputy. Captain Johnston was in Europe from January to September, 1945, and completed the Japanese part of the survey before coming to the Institute as Director in the spring of 1946.

The overall report of the survey and some of the overall reports of divisions were published by the U.S. Government Printing Office. The specialized reports covering individual plants and the reports on particular industries were reproduced from typewritten copy, with numerous illustrative charts, graphs, and maps. One-half or more of each report consists of this detailed illustrative material. The reports were not widely distributed and the Institute is fortunate in having virtually a complete set of the German reports of the Aircraft Division of the U.S. Strategic Bombing Survey.

Other Books Received

AERODYNAMICS

Jones, Bradley. **Aerodinámica Para Pilotos** (Aerodynamics for Pilots). (Dept. of State, Publication TC-202.) Wash., Govt. Print. Off., 1945. 174 p., diagrs. A translation into Spanish of Civil Aeronautics Bulletin No. 26, 1940, intended for those studying for C.A.A. examinations.

AIR TRANSPORTATION

Air Transport (Magazine). **A Market Study of Air Transport,** Our Swiftest-Growing Carrier. N.Y., McGraw-Hill Pub. Co., Inc., 1945. 48 p., illus. $1.00. The nature, growth, and development of air transport, its practices, purchases, and the methods of reaching the market. Statistical data are included.

Larsen, Spencer A., and Reitz, William. **Air Cargo Potential in Drugs and Pharmaceuticals.** (Wayne University Studies in Air Transport No. 3). Detroit, Wayne Univ. Press, 1946. 92 p., tables. $1.25. Analysis of the extent to which the airplane, under a given range of transportation charges, may serve as a carrier to domestic and foreign markets.

AIRPLANES

Anderson, N. O. **Manual de Aviación Para Pilotos** (Pilot's Airplane Manual). (Dept. of State, Publication TC-201.) Wash., Govt. Print. Off., 1945. 175 p., diagrs. The construction and maintenance of aircraft from the pilot's point of view. A translation into Spanish of Civil Aeronautics Bulletin No. 27, 1940, intended for those studying for C.A.A. examinations.

Bellhouse, Alan R. **Whose Plane Is That?** 5th ed. Sydney, Whitcombe & Tombs Pty. Ltd., 1945. 89 p., illus. 2*s.* 3*d.* An introduction to aircraft recognition, written in popular style and covering British, American, and Japanese military airplanes likely to be seen in the Pacific.

Commonwealth Aircraft Corporation Pty. Ltd. **Manual of Operating Instructions for the "Boomerang" Interceptor Aircraft.** (R.A.A.F. Publication No. 257.) Melbourne, 1943. 83 p., illus. Introductory notes for the pilot, followed by details on all controls and installations.

Commonwealth Aircraft Corporation Pty. Ltd. **Manual of Operating Instructions for the "Wackett" Trainer Aircraft.** (R.A.A.F. Publication No. 173.) Melbourne, 1941. 29 p., illus. Explanatory and instructional details on all the controls and installations, clearly illustrated with photo-diagrams. Detailed table of characteristics.

Curtiss Aeroplane and Motor Corp. **The Curtiss Standard JN4-B Military Tractor: Handbook.** Buffalo, 1917. 30 p., diagrs. Instructions for unpacking and assembling, and hints on flying.

Lloyd, F. H. M. **Hurricane: The Story of a Great Fighter.** Leicester, The Harborough Pub. Co., Ltd., 1945. 136 p. 7*s.* 6*d.* The part played by the Hawker Hurricane in the war, described in nontechnical language.

Real Photographs Co., Ltd. **Aircraft Recognition Drawing Book.** Southport, England, 1946. 32 p., illus. 2*s.* Brief specifications and pictures of British aircraft with partial sketches of each, to be completed as drawing exercises.

AIRPORTS

American Road Builders' Assn. **Airports: Design, Construction, Maintenance.** Chicago, 1945. 62 p., illus. Papers read at the annual meeting held at Chicago, January 16–19, 1945, including "Where Are We in Airport Design," by Harold J. McKeever; "Airport Construction, Equipment and Methods," by Theodore Reed Kendall; and "Airport Maintenance Beyond the Hangar Line," by Hal W. Hunt.

Fellows, Otis D. **Airports Program for Massachusetts Bay and Environs.** Boston, Mass., State Planning Board, 1946. 39 p., maps. Needs of the area and general location of airports to be developed over the next 10 years.

Madigan-Hyland, Consulting Engineers. **Airports and Air Traffic in the New York Area.** Vol. 1, Report on Traffic. June 25, 1946. N.Y., Department of Marine and Aviation, 1946. 6 maps, 31 charts. 158 p. Covers all aspects of traffic at LaGuardia Field and Idlewild Airport, with estimates of future activity to 1955. Two volumes to be published will cover physical aspects of the airport facilities, and revenues, expenses, and all pertinent financial data.

Mexico. Departamento de Aeronáutica Civil. **Manual Para el Control del Tránsito Aéreo en los Aeropuertos de la República Mexicana** (Manual for Air Traffic Control at Airports in the Mexican Republic). Mexico, D.F., 1945. 104 p., diagrs. Detailed regulations for approach, landing, taxiing, and take-off procedures, and radiotelephone communication.

Port of New York Authority. **Annual Report,** 25th, 1945. N.Y., 1946. 79 p., illus. In addition to a summary of developments in the matter of land and sea routes and terminals, the report includes the proposals of the Authority in connection with New York and New Jersey air transportation facilities.

Port of New York Authority. **Development of Newark Airport and Seaport.** N.Y., 1946. 43 p., illus. The engineering and economic problems involved in the future development of marine and air terminal facilities at Port Newark and Newark Airport.

ATOMIC ENERGY

Atom-Bomben Erschüttern die Welt (Atom Bombs Shake the World), by "Uranus." Zürich, Bildungsverlag, 1945. 72 p., illus. Sw. fr. 3.50. A popular account of the development and potentialities of the atomic bomb, compiled from press reports and official releases.

Brodie, Bernard, Editor. **The Absolute Weapon,** by Frederick S. Dunn, Bernard Brodie, Arnold Wolfers, Percy E. Corbett, and William T. R. Fox. N.Y., Harcourt, Brace and Co., 1946. 214 p. $2.00. A closely reasoned and informed review of the problem, particularly notable for the editor's discussion of the effect of the atomic bomb on warfare and military policy. Other topics are its influence on Soviet-American relations and on international relations in general. The book ends with an examination of the problem of international control.

Carnegie Endowment for International Peace. Committee on Atomic Energy. **Utilization and Control of Atomic Energy.** N.Y., 1946. 40 p. A plan for international control based on detailed studies carried out since December, 1945.

Semat, Henry. **Introduction to Atomic Physics,** rev. and enl. New York, Rinehart & Co., Inc., 1946. 412 p., illus. $4.50. Represents the content of a course taught at C.C.N.Y. to students who have had 1 year of general college physics and a course in the calculus. Major changes have been made in this revision; in the section on the nucleus certain topics have also been expanded. Other new topics, such as sources of nuclear energy and measurement of nuclear magnitude moments, have been added.

Wimperis, H. E. **World Power and Atomic Energy:** The Impact on International Relations. London, Constable & Co., Ltd., 1946. 87 p. 6*s.* A survey of the menace of the atomic bomb to peace, the general scientific basis of atomic power and its promise for increase of economic and industrial prosperity, and the need for control by responsible authority.

BIOGRAPHY

Bathe, Greville. **Citizen Gênet, Diplomat & Inventor.** Phila., Allen, Lane and Scott, 1946. 55 p., illus. A biographic essay on Edmond Charles Gênet, French ambassador to this country in 1793 and author of Memorial on the Upward Forces of Fluids, Albany, 1825.

Golubev, V. V. **Nikolai Egorovich Zhukovskii.** Issued by the Central Aero-Hydrodynamic Institute. Moscow, Izdatel'stvo Biuro Novoi Tekhniki NKAP, 1941. 94 p., illus. R.3. (In Russian.) A biography and résumé of the scientific work of the famous Russian aerodynamicist.

FICTION AND LITERATURE

Brennan, Dan. **Never So Young Again.** N.Y., Rinehart & Co., 1946. 273 p. $2.50. Novel of a young American flier in England.

Dedmon, Emmett. **Duty to Live.** Boston, Houghton Mifflin Co., 1946. 269 p. $2.50. Story of the crew of a Fortress stationed in England.

Driscoll, Ian H. **Mercury Sped On.** London, John Crowther, 1946. 222 p. 8*s.* 6*d.* Slightly modified historical facts are the basis for this novel of the development of Britain's Empire Air Routes ince 1923.

Gann, Ernest K. **Blaze of Noon.** N.Y., Henry Holt & Co., 1946. 298 p. $2.75. Novel of barnstorming, early air mail, and trailblazing of commercial aviation in the U.S.

Healy, Raymond J., and McComas, J. Francis. **Adventures in Time and Space,** an anthology of modern science fiction stories. N.Y., Random House, 1946. 997 p. $2.95. An excellent collection of 34 stories, of which 32 are from Astounding Stories. The book includes an article by Willy Ley on the V-2 rocket.

Hurren, B. J. **Second Dog;** A Collection of Wardroom Tales With an Aeronautical Flavor. Leicester, Harborough Pub. Co., Ltd. 157 p. 8*s.* 6*d.* Twenty-five short anecdotes as told by British seamen.

Martin, Hansford. **Send Them Summer.** N.Y., Harcourt, Brace & Co., 1946. 288 p. $2.50. Novel of the influence of the war on the life of an air cadet in America.

Wright, John. **Airman Singing.** London, Sidgwick & Jackson, Ltd., 1944. 50 p. 4*s.* 6*d.* Poems by an R.A.F. air-gunner.

GLIDING

Rütschi, H., Ed. **Segelflug;** Handbuch für den Schweizer Segelflieger (Gliding; A Handbook for the Swiss Glider Pilot). Olten, Verlag Otto Walter AG, 1944. 199 p., illus. Sw. fr. 12.50. Contains 23 chapters by various authors on the history, principles, equipment, operation, and uses of gliders, with lists of Swiss glider pilots and records.

HYDROSTATICS

Ramsey, A. S. **Hydrostatics, A TextBook for the Use of First-Year Students at the Universities and for the Higher Divisions in Schools.** Cambridge, Cambridge University Press, 1946. 169 p., diagrs. $2.25. Assumes acquaintance with the calculus and includes examples and answers at the end of each chapter.

INDUSTRY

Litchfield, Paul W. **The Industrial Republic;** Reflections of an Industrial Lieutenant. Cleveland, Corday & Gross Co., 1946. 201 p., illus.

$4.00. The relations of capital and labor since 1919, the present problems and their solution, with specific reference to the Goodyear Tire & Rubber Company, of whose board the author is chairman.

Proceedings of the Mexican-American Conference on Industrial Research. September 30–October 6, 1945. Chicago, Armour Research Foundation of the Illinois Institute of Technology, 1946. 176 p. $2.50. Addresses and discussions by 22 prominent delegates covering the theoretic aspects, educational aspects, and specific applications of industrial research in private and government laboratories, and in universities.

U.S. Surplus Property Administration. **Aviation-Gasoline Plants and Facilities;** Report . . .to the Congress, January 14, 1946. Wash., Govt. Print. Off., 1946. 65 p. $0.15. The Government investment in aviation gasoline facilities, economic aspects of disposal, and disposal policy.

U.S. War Assets Administration. **Patents, Processes, Techniques, and Inventions;** First Supplementary Report. . .to the Congress, June 27, 1946. Wash., 1946. 8 p. Description, value, and methods of disposal of patents relating to motor trucks and like vehicles.

INSTRUMENTS

Gemperle, A. **Das Barometer als Höhenmesser, Orientierungsinstrument und Hilfsmittel zur Wettervorhersage** (The Barometer As an Altimeter, As an Orientation Instrument and As an Aid in Weather Forecasting). Bern, Verlag A. Francke AG., 1940. 32 p., illus. An introduction to the principles and uses of the barometer.

Sperry Gyroscope Co., Inc. **Catalog of Aeronautical Equipment.** Great Neck N.Y., 1945. Illus. Detailed descriptions of flight and engine instruments and equipment, with outline drawings and colored cutaways.

JUVENILE LITERATURE

Brier, Howard M. **Skyblazer.** N.Y., Random House, 1946. 265 p. $2.00. Adventure and mystery with commercial aviation in the substratosphere as background.

Cook, Canfield. **The Flying Wing.** N.Y., Grosset & Dunlap, 1946. 216 p. $0.65. Adventures of Lucky Terrell with a spy ring as he flies a new jet-propelled flying-wing passenger airplane.

Emerson, Caroline D. **Mr. Nip and Mr. Tuck in the Air.** N.Y., Dutton & Co., Inc., 1946. 160 p., illus. $2.00. Two children's characters include some air travel in their new adventures.

Grey, E. **A Flier of the Northland.** London, Blackie & Son, Ltd., 1936. 239 p., illus. 9*s*. Adventures of two youthful aviators who helped the fire patrol in Northern Manitoba.

Lansing, Elisabeth. **Nancy Naylor, Captain of Flight Nurses.** N.Y., Thomas Y. Crowell Co., 1946. 241 p. $2.00. The further adventures of Nancy Naylor in the European theater.

Litten, Frederic N. **The Kingdom of Flying Men;** A Story of Air Cargo. Phila., The Westminster Press. 247 p. $2.00. Novel for youth of a group of veteran pilots and a small air line dealing in air cargo.

Montgomery, Rutherford G. **A Yankee Flier Under Secret Orders,** by Al Avery (pseudonym). N.Y., Grosset & Dunlap, 1946. 204 p. Three World War aces become involved with a German spy ring experimenting with atomic bombs in South America.

Rowland, Jasper M. **Chipper.** N.Y., American Crayon Co., 1946. 40 p., illus. $1.00. Children's story of a rabbit. One of his four adventures is in an airplane.

Young America's Aviation Annual, Edited by David C. Cooke. 6th Annual Ed. N.Y., Robert M. McBride & Co., 1946. 224 p., illus. $3.00. This edition reviews the achievements of air power in the war, both combat and technical, and describes recent military airplanes, including the jet-propelled P-80 fighter. The air lines in war and peace, and the manufacturing industry, are also reviewed.

MATERIALS

American Society for Testing Materials. **A.S.T.M. Standards on Rubber Products** (With Related Information). Phila., 1946. 540 p., illus. $3.25. Standards and tentative methods of test specifications pertaining to rubber products, in convenient form for use and reference. Also proposed specifications, published in draft form for criticism and comment.

METALS AND ALLOYS

American Society for Testing Materials. **A.S.T.M. Methods of Chemical Analysis of Metals.** Phila., 1946. 402 p. $4.00. Standards for the analyzing of ferrous and nonferrous metals and their alloys, and the newer photometric, polarographic and spectrochemical methods.

Bulian, Walter, and Fahrenhorst, Eberhard. **Metallography of Magnesium and Its Alloys;** A Translation From the German by the Technical Staffs of F. A. Hughes & Co., Ltd., and Magnesium Elektron Ltd. London, F. A. Hughes & Co., Ltd., 1944. 177 p. 15*s*. Distributed by Brentano's, Inc., 586 Fifth Ave., N.Y. $5.00. A translation of a German work published in 1942.

Johnson, F. **Heat Treatment of Carbon Steels.** Bklyn., N.Y., Chemical Pub. Co., Inc., 1946. 204 p., diagrs. $4.00. Intended as an aid to engineers in taking an active interest in the metallurgical study of the metals and alloys available for their use. Chapter headings include Practical Operations, Hardenability, Mechanical Properties (Testing), and Supplementary Notes.

MATHEMATICS

Colebrook, F. M. **Basic Mathematics for Radio Students.** London, Iliffe & Sons, Ltd., 1946. 270 p., diagrs. 10*s*. 6*d*. More advanced than the title indicates. Includes continuity, limits, series, differential and integral calculus, and the application of mathematical ideas.

Frazer, R. A., Duncan, W. J., and Collar, A. R. **Elementary Matrices,** and Some Applications to Dynamics and Differential Equations. N.Y., The Macmillan Co., 1946. 416 p. $4.00. A reprint at a lower price of a book first published in England in 1938. It is the only work in English presenting the algebra of matrices with investigations of the oscillations of airplanes and airplane structures as the principal background for demonstrations of applications.

Newton, Sir Isaac. **Sir Isaac Newton's Mathematical Principles of Natural Philosophy And His System of the World.** Translated into English by Andrew Motte in 1729. The Translation Revised, and Supplied With an Historical and Explanatory Appendix, by Florian Cajori. Berkeley, Calif., University of California Press, 1946. 680 p. $6.50. This revision of the English translation of *Newton's Principia* was the last work of Professor Cajori before his death in 1930. The mathematical terms have been brought up to date and it is the only modern version available.

METEOROLOGY

U.S. National Roster of Scientific and Specialized Personnel. **Meteorology As a Profession.** (Vocational Booklet 4.) Wash., Govt. Print. Off., 1946. 17 p., illus. $0.05. The meteorologist's duties, educational requirements, and professional opportunities are briefly described. Thirty publications are suggested for reading.

U.S. Weather Bureau. **Codigo para las Formas de Nubes y Estados del Cielo,** según el Sistéma Internacional de Classificación (Codes for Cloud Forms and States of the Sky, According to the International System of Classification). (Dept. of State, Publication TC-220.) Wash., Govt. Print. Off., 1945. 112 p., illus. Definitions, descriptions, and illustrations of cloud forms. A translation into Spanish of Weather Bureau Circular S, 1938, intended for observers reporting clouds in synoptic messages in the International Code.

MILITARY AND NAVAL AERONAUTICS

Lewis, Elmer A., comp. **Army Air Service Laws.** Wash., Govt. Print. Off., 1946. 73 p. $0.10. The texts of the laws chronologically arranged from 1913 to 1945, without an index.

Mitchell, Donald W. **History of the Modern American Navy.** N.Y., Alfred A. Knopf, 1946. 477 p., illus. $4.50. A useful, well-informed history covering the period 1883–1941. Aeronautics is included without historical details but with good interpretation of its development and place in the picture.

U.S. Office of the Chief of Naval Operations. **Pilots Choice** (NavAer 00-80T-25) Wash., 1945. 61 p., illus. Results of a poll of pilots setting forth the qualifications necessary for combat with the opposing undesirable characteristics, each with accompanying cartoon.

MODEL AIRCRAFT

Castellani, A. **Il Modello ad Elastico** (The Rubber-Powered Model). Cremona, L'Aviasone Populare, 1942? 83 p., illus. L.120. General principles, specific models, and working drawings.

Clerici, Gustavo. **Il Modello Volante.** Parte I., La Construzione. (The Flying Model. Part 1, Construction.) Milan, Movo, 1942. 251 p., illus., fold. charts. L.150. A detailed presentation of practical methods for the construction and assembly of flying model aircraft.

Morgan, Alfred. **The Boys' Book of Engines, Motors, and Turbines.** N.Y., Charles Scribner's Sons, 1946. 264 p., illus. $2.75. Numerous clear illustrations. Ten pages on aero engines.

Winston, Bernard B. **The Gas Modeler's Guide.** N.Y., America's Hobby Center, Inc., 1946. 167 p., illus. $1.00. Free-flight and control-line airplanes, radio control, contests, and clubs.

Winston, Bernard B. **Model Gas Engine Handbook.** N.Y., America's Hobby Center, 1944. 149 p., illus. $1.00. Detailed information such as ignition wiring designs, "don'ts," trouble shooting, and instruction sheets for principal engines.

NAVIGATION AND ASTRONOMY

Allen, John S. **Astronomy,** What Everyone Should Know. N.Y., Bobbs-Merrill Co., 1945. 199 p., illus. $2.50. Written in intimate style, with many helpful diagrams.

Hughes, Arthur J. **History of Air Navigation.** London, George Allen & Unwin, Ltd., 1946. 154 p. 10*s*. 6*d*. A history by a British authority, told partly by the use of navigation reports of pioneering and commercial flights between the two world wars. Both the past and the future are discussed in the final chapters on compasses, sextants, and drift and radio. This book fills a need for historical data on the subject and brings much scattered information together.

U.S.S.R. Voennyi Morskoi Flot. **Tablitsy dlia Opredeleniia Linii Polozheniia Korablia po Radiopelengu** (Tables for the Determination of the Lines of Position of a Ship by Radio Triangulation). Moscow, Izdatel'stvo Akademii Nauk SSSR, 1944. 137 p., diagrs. R.10. The tables can be used in latitudes from 0° to 80° to determine lines of position, with a maximum error of 15′, on a bearing from a radio station of known location no more than 270 miles distant.

PRODUCTION

Hinman, D. W. **Practical Designs for Drilling, Milling, and Tapping Tools.** 2d Ed. N.Y., McGraw-Hill Book Co., Inc., 1946. 416 p., illus. $4.50. The principles involved in designing, drafting, and using drilling jigs, gages, hand tools, and tapping and milling fixtures. Intended to clear up problems for the beginner, assist the advanced designer, and introduce new suggestions for the professional. Higher mathematics is avoided, and there is a chapter on special and standard machine operations to illustrate some of the progress made in that line during the war.

Simonds, Herbert R., and Bregman, Adolph. **Finishing Metal Products.** 2d Ed. N.Y., McGraw-Hill Book Co., Inc., 1946. 352 p., illus. $4.00. The 1935 edition is brought up to date to include the developments in the field during, and in the years immediately preceding, the war. New material on coloring metal, costs and estimates, and organic coatings.

Society of Automotive Engineers, Inc. **Aeronautical Drafting Manual.** N.Y., 1946. Looseleaf. $2.50. Expansion of an earlier manual covering only aircraft engine drafting to include practices that apply to the aircraft propeller and accessory industries, as well as to air-line industries. Complete rearrangement of the old manual plus numerous additions.

Tylecote, R. F. **Pressure Welding of Light Alloys Without Fusion.** (LM4-6/29) London, British Welding Research Assn., 1946. 16 p., illus. 5*s*. Results of attempts to weld overlapping sheets of nine aluminum and three magnesium alloys by the simultaneous application of heat and pressure at temperatures below their melting points.

U.S. Bureau of Naval Personnel. **Basic Machines.** (NavPers 10624) Wash., Govt. Print. Off., 1946. 183 p., illus. $0.35. Fundamentals of machinery for enlisted men of the Navy, in simple style with excellent illustrations.

Wald, A., and Wolfowitz, J. **Sampling Inspection Plans for Continuous Production Which Insure a Prescribed Limit on the Outgoing Quality.** (Reprinted from the Annals of Mathematical Statistics, v. 16, March, 1945.) Ann Arbor, Mich., Edwards Bros., Inc., 1945. 20 p. The plans are applicable to articles which can be classified as "defective" or "nondefective" and which are submitted for inspection either continuously or in lots.

Working, Holbrook. **Statistical Quality Control in War Production.** (Reprinted from the Journal of the American Statistical Assn., v. 40, December, 1945.) Wash., 1945. 22 p. Enrollment figures and details of extension courses under the plan of the Office of Production Research and Development to assist war industry to develop applications of statistical quality control.

RADAR

Stout, Wesley W. **The Great Detective.** Detroit, Chrysler Corp., 1946. 99 p., illus. Nontechnical account of the development and production of the SCR-584 (Radar) by the Chrysler Corporation. Production figures and details on distribution and use.

U.S. Joint Board on Scientific Information Policy. **Electronics Warfare;** A Report on Radar Countermeasures. Wash., Govt. Print. Off., 1945. 38 p. $0.15. Radar jamming, "window" dropping, and countermeasures throughout the war.

REACTION PROPULSION

Gussalli, Luigi. **The Interplanetary Travels by the Solar Radiations.** Translated from the Original Text by Jeanne Wiest. Brescia, Italy, Giulio Vannini, 1946. 92 p., illus. A system of space-ship propulsion is outlined, using the pressure of solar light in combination with the periodic throwing of fine spray-dust by means of V-2 or similar rockets. The English translation is literal rather than idiomatic.

Harper, Harry. **Dawn of the Space Age.** London, Sampson Low, Marston & Co., Ltd., 1946. 142 p., illus. 8s. 6d. Consists of three parts: The Story of the Rocket and the Coming of Atomic Power; Objectives of Space-Flight—the Moon, Mars and Venus; and Design and Construction of Vessels for the Navigation of Space. The activities of the British Interplanetary Society have, as shown in part three, reached a point where a rocket has been planned for a trip to the moon, with all the necessary supplies, clothing, and instruments.

Partridge, J. J., and Goulding, G. J. **Jets.** London, National Assn. of Spotters' Clubs, 1946. 16 p., illus. 1s. 6d. Brief introduction to the jet engine and some early applications with drawings and descriptions of early jet planes.

REFERENCE BOOKS

De Vries, Louis. **German-English Science Dictionary** for Students in Chemistry, Physics, Biology, Agriculture, and Related Sciences. 2d. Ed., Rev. and Enl. N.Y., McGraw-Hill Book Co., Inc., 1946. 558 p. $4.50. Many aeronautical terms are included. The first edition of 48,000 entries, published in 1939, has been enlarged by the inclusion of new terms and the addition of tables and lists of symbols and abbreviations.

Educators Guide to Free Films. Compiled and Edited by Mary F. Horkheimer and John W. Diffor. 6th Ed. Randolph, Wis., Educators Progress Service, 1946. 303 p. $4.00. Includes 41 items on aeronautics with description, running time, and source.

National Research Council. **Industrial Research Laboratories of the United States,** Including Consulting Research Laboratories. Compiled by Callie Hull. 8th Ed. (Bulletin No. 113.) Wash., 1946. 415 p. $5.00. A directory of 2,443 industrial research laboratories, indicating their specialties and facilities, indexed geographically and under 300 subjects. The personnel index contains over 7,800 names. Colleges are listed in an appendix. Industrial research laboratories listed include eight in aerodynamics, 69 in aircraft and accessories, and seven in aircraft engines, in addition to related subjects.

Schweizerischer Aerokalendar, 1946 (Swiss Aero Calendar, 1946). 9th year. Zürich, Aero-Club der Schweiz, 1945. 184 p., illus. A pocket diary listing personnel of Swiss organizations and official agencies, registered pilots and aircraft, and records.

STRESS ANALYSIS AND STRUCTURES

Illinois. University. Engineering Experiment Station. **Investigation of the Strength of Riveted Joints in Copper Sheets.** (Bulletin Series No. 360.) Urbana, 1946. 84 p., illus. $1.00. Tests to obtain information useful in designing riveted joints connecting copper sheets, by first determining unit strength that can be developed against failure by tearing out the rivets to the edge of the sheet, by rivet shear, and by rivet bearing; second, determining rivet pattern that will give the greatest efficiency against failure by shear tension.

Illinois. University. Engineering Experiment Station. **Residual Stresses in Welded Structures.** (Bulletin Series No. 361.) Urbana, 1946. 80 p., illus. $0.75. Tests to determine the magnitude of thermal stresses due to welding and to determine the strength and ductility of the resulting weld.

Prescott, John. **Applied Elasticity.** (London, 1924.) N.Y., Dover Publications, 1946. 666 p., diagrs. $3.95. A reprint of a book first published in England in 1924. It is written from the point of view of the engineer, developing the theory of elasticity for the solution of practical problems, and is a standard work on the subject.

Rostovtsev, G. G. **Stroitel'naia Mekhanika Samoleta.** Chast'l. (Airplane Structural Mechanics. Part 1.) Leningrad, Glavnaia Redaktsiia Aviatsionnoi Literatury, 1936. 372 p. R.5. A structural analysis of the biplane for advanced students of aircraft design. References are given in footnotes.

THERMODYNAMICS

Hawkins, George A. Thermodynamics. N.Y., John Wiley & Sons, Inc., 1946. 436 p. $4.50. A textbook designed for use in a one-year undergraduate college engineering course. By omission of the chapters on equations of state for real gases, combustion, the gas turbine and jet propulsion, general thermodynamic equations, and introduction to heat transfer, it can be used for a one-semester course. The author is a professor of thermodynamics at Purdue University.

WORLD AFFAIRS

MacFadden, Clifford H., Kendall, Henry M., and Deasy, George F. **Atlas of World Affairs.** N.Y., Thomas Y. Crowell Co., 1946. 179 p. $2.50. Maps and text on opposite pages intended to cover aspects of the present world which may influence future international affairs.

WORLD WAR II

U.S. 3d Service Group. **History of the 3d Service Group.** Eau Claire, Wis., Johnson Printing Co., 1945. 132 p. $6.50. Pictorial record of personnel and activities in training and in North Africa.

U.S. 13th Airborne Division. **The Unicorn.** Atlanta, Albert Love Enterprises, 1946. 112 p. $2.00. Pictorial record of personnel and activities in the United States.

European Theater

Bolitho, Hector. **Command Performance;** The Authentic Story of the Last Battle of Coastal Command, R.A.F. N.Y., Howell, Soskin, 1946. 262 p., illus. $3.00. In diary form, the story of hunting and sinking of German U-boats and shipping in the English Channel from May, 1944, to September, 1945.

Bozung, Jack H., Editor. **The 8th Sees England.** Los Angeles, Jack H. Bozung, 1946. 82 p. $3.00. A pictorial record of scenes familiar to the 8th Air Force.

Millis, Walter. **The Last Phase:** The Allied Victory in Western Europe. Boston, Houghton Mifflin, 1946. 130 p., illus., maps. $2.50. Plans and events from June 6, 1944, to May 8, 1945, some of which involved air operations and airborne units.

Savin, William A. **The Ninth Air Force Service Command in the European Theatre of Operations.** N.Y., Phillip Andrews Pub. Co., 1945. 94 p. $2.50. Pictorial record of the unit's personnel and activities, with text.

Tartière, Drue. **The House Near Paris;** An American Woman's Story of Traffic in Patriots. N.Y., Simon and Schuster, 1946. 318 p., illus. $2.75. Underground work in occupied France with the resistance, including the smuggling out of Allied fliers.

U.S. 440th Troop Carrier Group. **DZ Europe.** Greenville, S.C., The Hollenbeck Press, 1946. 203 p. $5.00. Souvenir style record of activities in Europe from June 6, 1944, to VE Day, with illustrated rosters of personnel.

Pacific Theater

Bennett, H. Gordon. **Why Singapore Fell.** Bombay, Thacker & Co., Ltd., 1945. 208 p., illus. Rs. 7-14. The campaign and fall, told mainly in diary form by the commander of the 8th Australian Division.

Crisp, Dorothy. **Why We Lost Singapore.** Bombay, Thacker & Co., Ltd., 1945. 175 p. Rs. 4-12. Documented account of the background and events of 1941–42.

Joseph, F. H. **Far East Report.** Boston, Christopher Pub. House, 1946. 96 p., illus. $2.00. Personal observations and experiences on an official flight to most of the American bases in the Pacific.

Kato, Masuo. **The Lost War;** A Japanese Reporter's Inside Story. N.Y., Alfred A. Knopf, 1946. 264 p. $2.75. What the author saw and felt as a correspondent in Washington before Pearl Harbor and throughout the war years in Japan including the American occupation. Some references to the Japanese aviation industry and military aircraft.

Oliver, Philip G. **The Hellbirds.** Dallas, Tex., P. G. Oliver, 1946. 118 p. $9.00. Pictorial record of personnel and activities of the 462d Bombardment Group in the Pacific.

U.S. Army Air Forces. **Mission Accomplished.** Wash., Govt. Print. Off., 1946. 110 p. $0.50. Interrogations of Japanese industrial, military, and civil leaders of World War II.

Winston, Robert A. **Fighting Squadron;** A Veteran Squadron Leader's First-Hand Account of Carrier Combat With Task Force 58. N.Y., Holiday House, 1946. 182 p., illus. $2.00. Air operations in the Pacific from the invasion of the Marshalls to the fighting in the Philippines—a sequel to Dive Bomber.

I. A. S. Library Facilities

To serve Institute members and others in the aeronautical industry, the Institute of the Aeronautical Sciences offers the facilities of:

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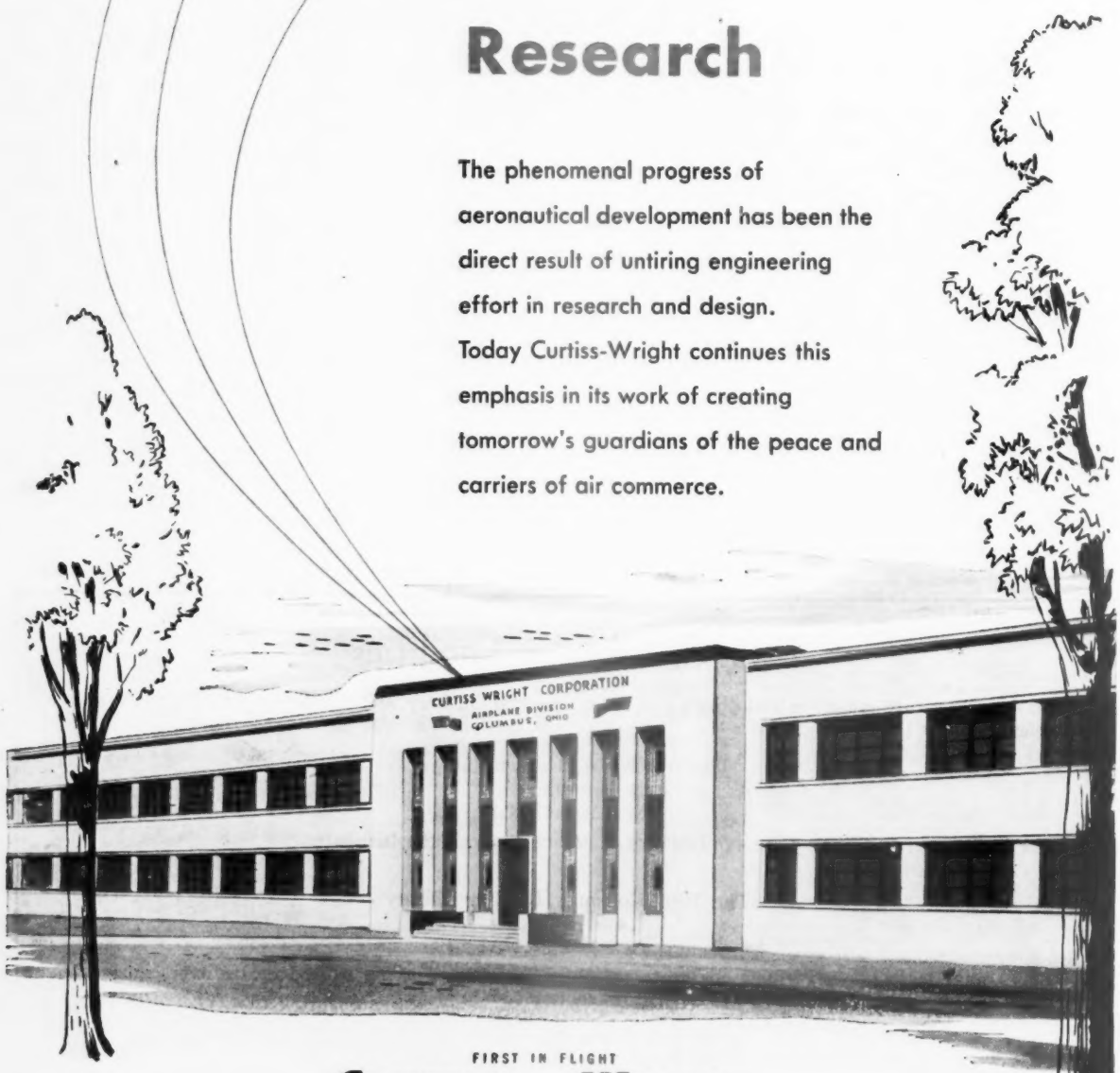

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Aerodynamicists and Aeronautical Engineers—Positions available for highly qualified technical personnel with good theoretical or experimental background to engage in development and test work in stability, control, high-speed, and supersonic aerodynamics. Projects include new designs of piloted and pilotless aircraft, new wind tunnels and associated equipment, and advanced testing techniques. Salary in accordance with qualifications and Civil Service regulations. In reply please give brief summary of personal qualifications, education and experience. Address: Director, David Taylor Model Basin, Washington 7, D.C.

Layout Draftsmen—College graduates preferred, with aeronautical or mechanical engineering degrees. Must have 3 to 5 years' experience in aircraft industry as layout draftsmen working on structures, stress analysis, and design. Plant located just outside Washington, D.C. Address inquiries to Engineering and Research Corporation, Riverdale, Md.

Engineers and Physicists—The Cleveland Laboratory of the National Advisory Committee for Aeronautics has openings for engineers and physicists to work in fundamental research applicable to aircraft propulsive systems. Research is in progress on engine performance, fuels, thermodynamics, compressors, turbines, and materials. Applications of the principles of fluid mechanics are being investigated in the speed ranges covered by subsonic, transonic, and supersonic flow rates. There are openings for professional men ranging from a starting rate of $2,644.80 per annum for men just out of college to $8,179.50 per annum for men with qualifying experience in their respective fields. Apply to National Advisory Committee for Aeronautics, Cleveland Airport, Cleveland, Ohio; Attention, Mr. John D. Tousignant.

Chief Aerodynamicist—Services of highly qualified aerodynamicist required to act as Chief Aerodynamicist. Applicants must be graduate engineers from recognized universities. Experience on personal aircraft desirable. Applicants should write, giving complete details of education, experience, and salary expected, as well as availability, to Fleet Manufacturing and Aircraft Limited, Fort Erie, Ontario, Canada.

Assistant or Associate Professor—An assistant or associate research professor with strong theoretical background wanted to engage in research in the field of stability and missiles. Advanced degrees preferred. Salary commensurate with training and experience. Apply by letter giving details of educational background, experience, salary expected, availability, and personal history, to D. W. Dutton, Director, Daniel Guggenheim School of Aeronautics, Georgia School of Technology, Atlanta, Ga.

Professor of Aeronautical Engineering—To teach advanced courses in aircraft design, materials and processes, and structures. Opportunity for research work in newly organized Navy Ordnance program provides for full year-round employment. Rank and salary dependent on educational background and experience. Considerable experience in aircraft industry and a permanent interest in teaching are desirable. Address: Dr. M. J. Thompson, Chairman, Department of Aeronautical Engineering, The University of Texas, Austin 12, Tex.

Aerodynamicists—One or two positions open for experimental and theoretical research in supersonic aerodynamics in Navy Ordnance development program. Preference given to applicants with experience in supersonic field but will consider those with good background of fundamentals and subsonic work who wish to acquire experience in supersonics. Salary dependent on education and experience. Address: Dr. M. J. Thompson, Associate Director, Defense Research Laboratory, The University of Texas, Austin 12, Tex.

Physicist or Research Engineer—To do basic research and development work in applied optics related to supersonic airflow visualization. Work includes application of spark and schlieren photography and interferometry to supersonic wind tunnel test program. Salary dependent on education and experience. Address: Dr. M. J. Thompson, Associate Director, Defense Research Laboratory, The University of Texas, Austin 12, Tex.

Electronics Engineers, Project Engineer—The U.S. Naval Air Station, Quonset Point, R.I., has vacancies for highly qualified and experienced electronics engineers, P-5, at $5,905.20 per annum; P-6, at $7,102.20 per annum; and a project engineer, P-3, at $4,149.60 per annum. Applications (Civil Service Form 57) are desired from persons who feel that they are capable of performing at the above-mentioned professional level, and should be mailed to the Recorder, Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I.

Chief Engineer—Experienced engineer needed to assume responsibility for stress analysis and C.A.A. approval of new personal airplane. Initial position would be as Chief of Structures, with opportunity to assume Chief Engineer's position if experience and other qualifications are satisfactory. Opportunity for investment in the company if desired. Address replies to The Dansaire Corporation, Dansville, N.Y.

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Aeronautical Engineers—The Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I., announces that a limited number of applications are now being accepted for the position of Aeronautical Engineer (Power Plants), P-3, $4,149.60 per year. Applicants must show that they have successfully completed a full 4-year course leading to a Bachelors' Degree in Aeronautical Engineering in a college or university of recognized standing; or 4 years of successful progressive aeronautical engineering experience. In addition, applicants must show 3 years of progressive professional aeronautical engineering experience involving aircraft power plants. Graduate study in aeronautical engineering involving aircraft power plants successfully completed in a college or university of recognized standing may be substituted for experience year for year, up to a maximum of 3 years. Applicants applying for this position should mail Standard Civil Service Form 57 to: Recorder, Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I.

Research Engineer—Responsible position open with small corporation engaged in development engineering on aircraft instrumentation and control systems. Background of mechanical engineering or applied physics required. Address inquiries to Box 388, Richmond, Va.

Engineers and Physicists—Advanced positions are open to high-type engineers and physicists with master's or doctor's degrees to perform research, development, and design studies relating to high-speed aircraft and missiles. Salaries commensurate with ability. Excellent working conditions. Address inquiries to R. C. Blaylock, Chief Engineer, Curtiss-Wright Corporation, Airplane Division, Columbus 16, Ohio.

Engineers, Technicians—The National Advisory Committee for Aeronautics at Langley Field, Va., has openings for engineers and technicians to work on the design, development, and application of instruments for use in its wind tunnels and other aeronautical research facilities. Currently, a large portion of the instrumentation is devoted to speeds considerably greater than the speed of sound and to the development of pilotless aircraft and guided missiles. There are openings for professional men ranging from a starting rate of $2,644.80 per annum for men just out of college to $4,902 per annum for men with experience in instrument work. There are also openings for instrument mechanics and instrument makers, ranging from $2,034 per annum for men who have had a minimum of 2 years of experience, other than routine production, in construction, test, installation, or maintenance of mechanical, electrical, electronic, or optical instruments to a $3,090 per annum starting rate for first-class journeymen. Apply to Instrument Research Division, National Advisory Committee for Aeronautics, Langley Field, Va.

Aeronautical Engineers—To participate in design and development program of new aircraft in Engineering Branch. Immediate openings for aerodynamicists, flight test engineers, power plant engineer, design draftsmen. Address inquiries to Edo Aircraft Corporation, College Point, N.Y., Attention of Mr. C. J. Libby, Administrative Engineer.

Graduate Aeronautical Engineer—Small expanding engineering and manufacturing organization located in Houston, Tex., has a job opportunity for a recent engineering graduate interested in the design and/or manufacture of personal airplanes. Write giving complete pertinent information, including interests, experience, and starting salary expected to Anderson, Greenwood and Company, Sam Houston Airport, Houston, Tex.

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Heating and Ventilating Engineer—Senior heating and ventilating engineer, familiar with the principles of heat exchange and air conditioning applicable to aircraft design, is required to act as Group Leader in the Design Office of a large aircraft manufacturing company in Montreal. Candidates should be graduate electrical, mechanical, or aeronautical engineers and should have at least 5 years' experience, including 3 years' specifically in the above work, and 1 year of supervisory experience. Applicants should write giving details of educational background, experience, salary expected, and availability to Canadair Limited, P.O. Box 6087, Montreal, Quebec, Canada.

Mechanics—Line Maintenance—Forty hours (rotating shifts). $1.26 per hour with periodic increases. Four years' minimum experience in multi-engined aircraft (C-54 experience desirable). Preference given for experience in electrical or instrument line maintenance and Aircraft and Engine Licenses. Contact Personnel Department, American Overseas Airlines, LaGuardia Field, N.Y.

Mechanics—Foreign Service: Paris, Iceland, Azores, Greenland. Foreman, $325 per month; lead mechanics, $325 per month; mechanics, $262.50 per month; $175 in addition to monthly salary for overseas duty. One year C-54 experience minimum, with an additional 3 years' experience in line maintenance, and Aircraft and Engine Licenses. Contact Personnel Department, American Overseas Airlines, LaGuardia Field, N.Y.

Instructor—Wanted by Department of Mechanical Engineering beginning in the fall quarter to teach undergraduate courses in aeronautics and courses in heat power engineering. Must have good academic training and some teaching experience; should have practical experience in aeronautical engineering and ability to do research. Salary up to $4,500 based on training and experience. Apply to Department of Mechanical Engineering, College of Engineering, University of Kentucky, Lexington 29, Ky.

Aeronautical Engineers—Group Engineers in stress, structural test, and aerodynamics; lead and major engineers in design, aerodynamics, stress analysis, and structural test wanted immediately for development and production engineering work on feeder-line airplane (Boeing 417) and military aircraft. Write Chief Administrative Engineer, Boeing Airplane Company, Wichita Division, Wichita, Kan.

Aeronautical Engineers—Qualified Engineers are urgently needed for development work on flight test instrumentation at Wright Field, Dayton. Attractive positions are open for research engineers (electrical, electronic, aeronautical, mechanical) with previous industrial experience in aircraft instrument development. Salaries range from $2,644 to $7,102 with the additional benefits of Federal Civil Service. Applicants may submit Civil Service Form No. 57 (obtained at local Post Office) to Secretary, Civil Service Board of Examiners, Air Matériel Command, Wright Field, Dayton, Ohio. Attention: TSFIS.

Research Designer—Airplane designer, with previous experience in applied mechanics, aerodynamics and stress analysis, to lead aircraft and missile design group. Advanced degree desirable. Thorough knowledge of jet propulsion necessary. Replies will be held in strict confidence. Write Cornell Aeronautical Laboratory, Employment Office, Buffalo 5, N.Y.

Thermodynamicist—With strong theoretical background to engage in research work in the field of jet propulsion. Advanced degrees preferred. Replies will be held in strict confidence. Write Cornell Aeronautical Laboratory, Employment Office, Buffalo 5, N.Y.

Aeronautical Engineers—The U.S. Naval Air Station, Jacksonville, Fla., requires the services of several highly qualified aeronautical engineers with power-plant or structures background, and preferably with some production experience. Salaries range from $2,980 to $5,180 per annum. Applications are now being accepted. Interested persons may obtain Civil Service Application Form 57 from their local post office and forward, completely filled out, to the Recorder, Industrial Relations Department, U.S. Naval Air Station, Jacksonville, Fla.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

Engineers—The Army Air Forces Air Institute of Technology being established at the Air Matériel Command, Wright Field, Dayton, has several openings for qualified professors and engineers to administer and to teach on a graduate and undergraduate level in the College of Engineering (Aeronautics). Starting salary ranges from $4,300 to $7,175, depending on position and qualifications. Employment will be effected in accordance with provisions in Civil Service Regulations. As faculty member, applicant should be capable of expanding into a research and consulting relationship with the various A.M.C. Engineering Division Laboratories. Write Commanding General, Air Matériel Command, Wright Field, Dayton, Ohio, Attention TSPCP-1, setting forth personal data and qualifications, education and experience; or forward Civil Service Form 57 available at post office.

Aeronautical Engineers—Thoroughly trained, experienced, and qualified to deal with problems in aerodynamics and thermodynamics. Opportunity to participate in development work arising from the application of advanced types of airplane power plant and resulting high-speed performance. Write giving education and experience, to the Industrial Relations Department, Consolidated Vultee Aircraft Corporation, Vultee Field Division, 842 South Lakewood Blvd., Downey, Calif.

Aerodynamicists—Immediate work is available for three qualified engineers with Kaiser Fleetwings, Inc. First man must be a stability and control specialist with at least 2 years' experience, some experience with problems related to flight at transonic and supersonic speed. Second man must be a specialist in aircraft performance estimation with a minimum of 2 years' experience, familiar with compressibility phenomena and with means of accounting for these phenomena in performance estimation. Third man must be familiar with general aerodynamics work and possess some knowledge of the characteristics of ram jet, pulse jet, and rocket jet engines. Good background in thermodynamics is necessary. Address reply to G. G. Cudhea, Chief Engineer, Kaiser Fleetwings, Inc., Bristol, Pa.

Assistant Professor—To teach applied mechanics, strength of materials, and fluid mechanics. A young man with M.S. degree preferred. Applicant should have special qualifications in the field of hydraulics and fluid mechanics. Opportunity to work in fluid meters research and the development of a fluid mechanics laboratory. Address inquiries to Department of Mechanics, University of Oklahoma, Norman, Okla.

Aerodynamicists—College graduates with sound theoretical training and at least 1 year of graduate study in compressible subsonic flow and supersonic flow to do research and test work in the Supersonic Wind Tunnel of the Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland. This is by far the largest operating supersonic wind tunnel in the country. Remuneration in accordance with qualifications. Write, giving education and experience, to The Commanding General, Aberdeen Proving Ground, Maryland, Attention: Director, Ballistic Research Laboratories.

643. Professor of Aeronautical Engineering—To take charge of this work in a well-established department where specialization is largely in aircraft propulsion and aerodynamics. Large graduate enrollment, good industrial contacts, and opportunities for consulting and research work. Salary attractive.

640. Stress Engineer—Highly qualified engineer, up-to-date on commonly used stressed-skin methods, wanted for a Swedish aircraft company for a period of 1 to 2 years. Good salary and traveling expenses paid. In applying please give brief sketch of personal qualifications, education, and experience.

634. Chief Engineer—Leading aircraft accessory firm making mechanical devices for aircraft. Located in a desirable Midwest city. Excellent opportunity for the proper man. Should be experienced in machine design, electrical design, small mechanisms, and possibly small rotating machinery. Must be experienced in handling people, supervising design, making engineering decisions for production, and supervising large number of projects. Please send complete information in first letter on entire background, including salary requirements and recent salaries. Our employees know of this opening and therefore applicants will not be embarrassed by writing to their own employer.

629. Assistant Professor—To conduct classes in airplane detail design and stress analysis in large engineering college. Must have aeronautical engineering degree and industrial experience. Advanced degree preferred but not essential. Immediate appointment. In replying, please submit brief record of education and experience.

627. Aeronautical Engineer—Civil Service position open immediately in Washington, D.C., for aircraft engineer with several years of progressive experience in structural design. Good opportunity for permanent appointment for engineer having proper qualifications. Duties involve responsibility for accurate investigations of special design problems and authoritative review and evaluation of major structural design features of new military aircraft to ensure compliance with Navy requirements and good engineering practice. Salary $5,905 per year. In applying give brief sketch of personal qualifications, education, and experience.

626. Propeller Project Engineer—Immediate permanent opening for project engineer with design experience in controllable-pitch propellers from 65 to 200 hp. Good testing facilities available and excellent opportunity for advancement with established Mid-West manufacturer. Reply stating full particulars of past experience, salary required, and other useful information.

616. Associate or Full Professor—A leading Midwestern university which is developing an extensive graduate instruction and research program in the fields of high velocity aerodynamics and jet propulsion needs an additional permanent staff member. Teaching will consist of one-third to one-half of load, balance on research. Rank will be Associate or Full Professor. Salary attractive; advanced degree required plus practical experience.

608. Patent Engineer or Attorney—Position requires at least 5 years' industrial experience in the preparation of patent applications covering electromechanical and electronic mechanisms such as control systems, servomechanisms, industrial instruments, automatic pilots for aircraft or gyro instruments. Electrical Engineering or Physics degree combined with degree in Patent Law preferred but not mandatory. Position requires ability to assume full charge of a small Patent Department, persistent follow-up of engineers to obtain patentable ideas.

607. Design Engineer—Position requires at least 5 years' industrial experience in the layout and design of electromechanical mechanisms such as controls, industrial instruments, aircraft instruments, automatic pilots, or gyro instruments.

SLEEVE RIVETS

NOW AVAILABLE

Sleeve rivets, an invention of the Douglas Aircraft Company, after two years of research and experimentation, are now available to the aircraft industry through the Vic Pastushin Industries, Inc., licensed manufacturers and distributors.

HERE ARE THE ENGINEERING FACTS

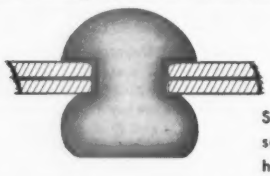
COUNTERSINK SLEEVE RIVET

A sleeve rivet is a standard aircraft aluminum rivet, the shank of which is covered with a sleeve of dead soft aluminum tubing with a wall thickness of .004 inch. The head end of the sleeve is flared to match the head of the rivet and the tail end is peened to cover the radius end of the rivet shank. Sleeve rivets are available in round head, countersink head, and flat head types. Sleeve rivets are used in such assemblies as integral fuel tanks, oil tanks, etc., where fluid tight joints are required. Employing conventional riveting methods, the soft sleeve flows under force of rivet expansion, filling all hole irregularities and bonding itself to the aluminum sheet, extrusion, etc., to form a fluid tight seal. In the fabrication of flush dimple assemblies the countersink sleeve rivet is extremely adaptable, as the sleeve, in addition to its bonding qualities, compensates for irregularities in the dimples of sheet metal.

Cross section of countersunk sleeve rivet showing flow (indicated by red) of sleeve after assembly. Note compensation for hole and dimple irregularities.

ROUNDHEAD SLEEVE RIVET

Photomicrographs, after assembly, show that the sleeve in a sleeve rivet permeates into all hole irregularities, under the head and under the hammered end of the rivet, beveled edges of sheet skin, dull drill serrations in holes, etc. Specific manufacturing errors which sleeve rivets tend to compensate are—holes too large; holes out of round; improper burring; mis-match of holes; improper fit in dimples and countersinks; and poor driving technique. No loss of strength, either static or fatigue, results from the use of sleeve rivets.



Sleeve (indicated by red) provides seal under head as well as under hammered shank of rivet.

Sleeve rivets are the result of two years of research and "shake-down" tests. Their dependability for assemblies where fluid tightness is mandatory is thoroughly proven. Sleeve rivets are being used on the Douglas DC-4, the new Douglas DC-6, new type of military airplanes, and commercial airplanes of foreign manufacture Check your *requirements—order your sleeve rivets today.*

Immediate Delivery

VIC PASTUSHIN INDUSTRIES, INC.

5651 West Century Blvd., Los Angeles Municipal Airport
Los Angeles 45, California

Engineering degree preferred but not mandatory. Position requires ability to assume responsibility for the mechanical design in connection with one or more projects and close cooperation with the Project Engineer.

606. Senior Project Engineer—Position requires at least 5 years' industrial experience in the basic development and design of electromechanical and electronic mechanisms such as control system, servomechanisms, industrial instruments, automatic pilots for aircraft, or gyro instruments. Electrical Engineering or Physics degree preferred but not mandatory. Position requires ability to direct several assistants in the handling of one or more major projects.

605. Senior Designers—Wanted by aircraft-engine manufacturer. Will make major design layouts of engine and component parts. Must be able to make all necessary design computations. Should have several years' experience with internal combustion engines. Location Midwest.

604. Senior Layout Men—Wanted by aircraft-engine manufacturer. Must have extensive experience with internal-combustion engines. To make complicated layouts from specifications, drawings, sketches, or notes furnished by engineers or designers. Should have considerable knowledge of manufacturing processes. Location Midwest.

598. Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in preliminary investigations of new aircraft designs and airplane performance. Salary between $4,149 and $4,902 per year. In applying please give brief sketch of personal qualifications, education, and experience.

597. Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in structural design and research. Salary between $3,397 and $5,905 per year. In applying please give brief sketch of personal qualifications, education, and experience.

595. Modelmakers—Craftsmen skilled in the use of hand and power tools to close tolerances wanted for model work by growing industry in the West. Experience in making wind-tunnel, free flight, and tow basin models for Army, Navy, N.A.C.A., or industry desirable. Position permanent. Please state full particulars in first letter, including age, experience, references, and salary desired.

593. Resident Sales Engineers—Near New York, Boston, Bangor, Albany, Scranton, Philadelphia, Richmond, Roanoke, Columbia, Jacksonville, Birmingham, Nashville, Cincinnati, Pittsburgh, Buffalo, Detroit, Chicago, St. Louis, Little Rock, New Orleans, San Antonio, Dallas, Oklahoma City, Kansas City, Omaha, Minneapolis, Helena, Casper, Denver, Albuquerque, Phoenix, Salt Lake City, Carson City, Boise, Seattle, Portland, San Francisco and San Diego. If you live within a reasonable distance from these cities and are willing to represent a new young firm of consultants in them and surrounding communities on a straight commission basis, kindly submit your complete background and present status.

591. Engineer—To direct production. Graduate engineer, or equivalent, with practical production experience, wanted to direct manufacturing activities of medium-sized East Coast concern specializing in precision equipment sold in the aircraft and industrial fields. Man desired should be capable of coordinating engineering development with production requirements; also of coordinating production control, tool design, costing, etc. New York City vicinity. Salary commensurate with experience.

586. Project Engineer—To handle a complete helicopter development program. Should have not less than a Bachelor's degree in engineering and at least 5 years of rotary wing experience. In replying, applicants should submit complete background information and a recent photograph.

584. Chief Project Engineer and Several Project Engineers—For design and development work in various forms of jet propulsion. Prefer men having some experience with rockets, ramjets, pulse-jets or turbojets. Experience in performance analysis desirable. Eastern location. Reply by letter stating details of education, experience, personal data, and salary desired.

583. Aerodynamicist—For design and development of diffusers, nozzles, compressors, etc., in connection with jet propulsion development program. Prefer man familiar with transonic and supersonic airflow. Eastern location. Reply by letter stating details of education, experience, personal data, and salary desired.

582. Thermodynamicist—Preferably with internal combustion experience for development work in connection with various forms of jet propulsion systems, including cycle analysis, combustion chamber design, etc. Familiarity with rocket and jet fuels desirable. Eastern location. Reply by letter stating details of education, experience, personal data, and salary desired.

581. Aeronautical Engineer—With airplane stability and control experience wanted by electronics company engaged in guided-missiles development. Location in vicinity of Boston. Good opportunity for right man.

571. Executive Engineer—Established West Coast helicopter company offers unusual opportunity for highly qualified engineer. Responsible for administration, programming, and control of engineering. In addition to technical training and experience, must have administrative and organizing ability and knowledge of production and procurement problems. Write full qualifications.

568. Personnel—An expanding southern New England helicopter company has positions available in several fields for personnel interested in rotary wing aircraft. Experience in helicopters is desired but not necessary. Give full education and experience.

567. Engineers—One of the largest engine companies located in Midwest engaged in extensive and continuing development program on nonrotating aircraft propulsion engines has openings for the following personnel:

Development Engineer—An idea man with good theoretical and practical background to direct activities of engineering group devoted to preliminary design and analysis.

Thermodynamicist — Research - minded with good theoretical background, advanced degrees preferred.

Vibrations and Structures Engineer—A man with aircraft and aircraft engine design experience, with an interest in analytical vibration problems.

Instrumentation Engineer—A man with a good understanding of wind-tunnel instrumentation, familiar with electronic, optical, and other instrumentation means suitable for use in studying aerodynamic and thermodynamic problems.

Mechanical or Aeronautical Engineers—Up to 5 years' experience, interested in research and development activity in a rapidly expanding program.

Aerodynamicist.

Physicist.

548. General Manager—For large and active aircraft concern located in the East. In addition to proved administrative ability and all other qualities suited to a general manager must have many years of successful aircraft production experience. Good position for a good man. State qualifications. Correspondence will be kept confidential.

538. Engineers—Experienced engineers wanted for project engineering and design evaluation work on pilotless aircraft. Aeronautical graduates with training or experience in electronics preferred. Location Washington, D.C.

526. Aeronautical Engineers—Positions open in Washington, D.C., for aerodynamicists with design and research experience in high-speed aerodynamics and stability and control or aircraft performance analysis. Salary between $4,149 and $4,902 per year. In applying, please give brief sketch of personal qualifications, education, and experience.

518. Power-Plant Design Engineer—For supervision of design of power-plant installations. Will also supervise design of mechanical equipment, including heating and ventilating equipment, hydraulic, vacuum, and oxygen systems and cabin supercharging systems in airplanes. Must have mechanical or aeronautical engineering degree with over 7 years' experience in this work in aircraft industry. Position available in Midwest airplane company.

511. Aeronautical Engineers—To teach mathematics, primary and advanced aeronautical engineering subjects including design and stress analysis in a Midwestern university.

490. Assistant or Associate Professor—Sought by Aeronautics Department of Engineering College to teach undergraduate and graduate courses in aerodynamics, aircraft structures, or aircraft propulsion. Must have good academic training and teaching experience; constructive interest in aeronautical research and development, preferably industrial or laboratory experience in this field. Starting salary range: $4,000 to $6,000 depending upon qualifications.

AVAILABLE

641. Aeronautical Engineer—B.Ae.E., Rensselaer Polytechnic Institute, 1939. Age 31, married. Private pilot. Eight years' design and field engineering work including administrative and supervisory experience for major aircraft accessory manufacturer. Ground and flight test experience, both Army and postwar commercial planes. One year project engineer and market analyst for development of light-plane products. Well-established West and East Coast aircraft contacts. Desires administrative or sales engineering position in aircraft or allied industry. Prefers East or West Coast. No objection to traveling. Available immediately.

639. Stress Analyst—Ten years' varied experience as stress analyst. In charge of complete stress and static test data for several small companies. Chief of Structures for a well-known personal plane manufacturer. Experienced in all-wood, steel tubular, and all-metal aircraft. Desires position relating to structures and utilizing the maximum of experience. Midwest or Eastern location preferred.

638. Aeronautical Engineer—B.S. in M.E., 1934, New York University (Guggenheim School of Aeronautics). Eight years' general aircraft engineering experience, including positions as Project Engineer, Chief Aerodynamicist, and Acting Chief Engineer on Naval aircraft, helicopters, and amphibians. Available for responsible position immediately.

637. Mechanical and Aeronautical Engineer—B.S. in M.E., Aeronautical Engineering option, 1936. Will receive M.S. degree in M.E. during present school year. Two years' experience machine tool design. Three and one-half years' experience in aircraft propeller design and vibration research. Almost 1 year's experience in aircraft automatic landing electronic equipment research. Thirty-nine months' service in Army Air Forces Air Matériel Command's Engineering Division Laboratories as Project Officer with considerable supervisory responsibilities. Highest references. Desires position in engineering liaison, sales, or development in aircraft or mechanical equipment manufacturing.

636. Mechanical Engineer—Age 28. Interested in engineering sales. Three years' experience in steel industry as specification writer, field engineer, and maintenance foreman. Three years' experience in the aircraft industry as design layout draftsman and flight-test engineer. Employed at present by research and development engineering concern working on aircraft gas turbines.

635. Sales Engineer—Graduate aeronautical engineer with 4 years' experience in design of aircraft and hydraulic equipment; holder of private pilot certificate. Desires position as a Sales Engineer (not necessarily in aircraft). Single. Free to travel. Location open.

633. Executive Assistant and Industrial Engineer—Age 38, single; 13 years' engineering experience including cost analysis, planning and scheduling production, sales forecasting, budgetary control, etc., as well as airport management. Can assist on product development and production of plastic structures and/or prefabricated houses. Also qualified to handle business relations with Government agencies. Separating from A.A.F. after 2 years overseas and 3 years' procurement and development engineering.

632. Aeronautical Engineer-Export—B.Ae.E., Rensselaer Polytechnic Institute. Ex-Naval Officer with 1 year's liaison engineering experience on high-speed research; 1 year's electronics training in the Navy; 1 year's practical work in aircraft production; 3 months' experience as buyer for export, plus publicity work. Graduate of European high school; has done atomic physics graduate work. Desires participation in export or establishment in an engineering product manufacturing company or airways in Southern Europe, South America, New York, or Los Angeles area.

631. Test Pilot—Graduate aeronautical engineer. Over 4,000 hours' single- and multiengined ratings. Instrument and instructor ratings. Radio license. Three years' test pilot for Navy. Experienced in making engineering reports. Prefers test flying work with engineering work anywhere in the United States.

630. Aeronautical Engineer—Graduate. Seventeen years' well-rounded experience with several leading aircraft manufacturers and U.S. Navy. Jet-propelled and supersonic pilotless aircraft. Design supervisory, organizational, and executive background, all phases. Previous salary in $9,000 range.

628. Professor of Aeronautical Engineering—Bachelor's Degree in Physics; graduate work in mathematics. Author of engineering textbook in aerodynamics. Four years' teaching experience in aeronautical engineering department at Southern engineering school. Experience in teaching senior work in aerodynamics, airplane layout and design, and aerodynamic laboratory with instructional wind-tunnel work. At present in charge of all aeronautical courses and development of aeronautical laboratory in leading engineering university. Desires permanent professorship in aeronautical engineering department where aeronautical graduate work is available.

625. Industrial and Aeronautical Engineer—B.S. in Mechanical and Electrical Engineering; 2 years' postgraduate Aeronautical Engineering. Twenty-one years' naval aviator; wide experience operating, maintenance and overhaul various types aircraft and engines. Retired as a Commander, U. S. Navy. Four years' shop superintendent in factory manufacturing aircraft and aircraft engines. Five years' quality manager for one of the largest aircraft manufacturers. Desires position as quality manager or manufacturing executive.

623. Manufacturers' Technical Sales Representative—Aeronautical design engineer experienced in technical sales representation desires connection with manufacturer or distributor of aviation products in selling to East Coast aircraft manufacturers. Ten years' experience in the aircraft industry includes positions as technical sales representative, design engineer, and project engineer. Salary or commissions. Holds pilot certificate and will travel in company owned or privately owned aircraft.

622. Aeronautical Engineer—Bachelor of Aeronautical Engineering, New York University, 1944. Limited experience in engineering department of a large aircraft manufacturing concern. Two years' administrative experience as an officer in the U.S. Army. Speaks Polish, German, and Russian. Desires a position in engineering department of aircraft manufacturing concern.

621. Aeronautical Engineer—B. of Ae.E., New York University. Three years' experience in aircraft stress analysis, including aerodynamic loading, salvage, and design. Some light-plane flying experience. Holds Marine Engineer's license obtained in service. Desires responsible position doing aeronautical or mechanical engineering work. New York City or adjacent area preferred. Available immediately.

620. Executive—French resident in U.S.A. since 1940. Varied experience in aeronautical, automotive, and mechanical engineering. Research minded, many ideas for future development. Has occupied high responsible administrative official positions. Recently, Consulting Engineer in charge of a complete helicopter project covered by his own patents. Desires position in which engineering background, administrative training, and knowledge of French and European countries would be of value.

619. Public Relations Specialist—B.S. in Commercial Aviation; Journalism minor. Ten years' experience aviation publicity and editorial work. Aggressive and tenacious with influential world contacts. Pilot, radio operator, and mechanic with working knowledge of engineering, manufacturing, distribution, and transport. Desires career position with aviation firm or agency aviation account. Location immaterial. Résumé on request.

618. Meteorologist-Engineer—Graduate meteorologist and engineer; B.S. Meteorology, New York University; B.S.M.E., Case School of Applied Science. Age 28. Served as commissioned meteorologist with A.A.F. in U.S. Served as operations and dispatch officer with A.T.C. overseas for 14 months. Three and one-half years in service. Position wanted with air line or other concern interested in air transportation. Interested primarily in flight operations or traffic promotion work. Holder F.C.C. radio permit and C.A.A. Tower Controller's Certificate. Will consider work in domestic or foreign fields.

615. Aeronautical Engineer—Age 27, B.A., Columbia University, 1939; B.S. in Aeronautical Engineering from M.I.T. in 1942; M.S. from M.I.T. in 1945 as result of course in servomechanisms and instrumentation sponsored by Army Air Forces. Associated for 4½ years with Army Air Forces Air Matériel Command, Engineering Division, as aerodynamicist concerned with aircraft stability and control problems, including direction of flight tests, instrumentation, analysis of wind-tunnel and flight-test data, and design evaluation. Desires position as aerodynamicist concerned with aircraft stability and automatic guidance problems.

614. Experimental Test Pilot—Available immediately for any research problem or experimental project in helicopter or conventional types of aircraft from small personal craft to four-engined or pursuit, land or sea. One thousand hours' experimental time in helicopters and military types of pursuit and multiengined. Six thousand hours' pilot time with 4,500 hours certified. Pilot since 1921, licensed since 1928. Formerly, Chief Test Pilot and Assistant Chief Experimental Test Pilot for prominent companies. Excellent experimental training in all phases of such operations, with high percentage of data obtained satisfactory to engineering. Checked out at Mayo Clinic altitude chamber and centrifuge with above average record. Commercial, single, and multiengined land, single-engined sea, and flight instructor ratings. Detailed résumé on request.

613. Administrative or Executive Engineer—Registered Professional Aeronautical Engineer, with over 8 years of broad administrative, supervisory, and some design experience, desires executive or administrative position in either prime or assisting capacity. Will definitely consider position in other than aircraft or allied industry, or any position requiring initiative, responsibility, and a combination of business and engineering experience and training. No objection to traveling. Geographical location unimportant.

612. Airline Engineer—Age 35, A & E licenses, Aeronautical degree; approximately 10 years' experience in maintenance and maintenance engineering with a major air line and recent experience as Assistant Chief Engineer for company manufacturing aircraft testing equipment. Seeks position with an air-transport company or manufacturer of aircraft equipment where intimate knowledge of air-transport maintenance problems and procedures will be of value.

611. Manufacturing Executive—M.E.; 26 years' experience in production management. Thoroughly familiar with all phases of modern methods and precision machinery, tooling, production control, procurement, and plant organization. Automotive and aircraft manufacturing background. Experience covers both aluminum and molded plywood construction.

610. Aeronautical Engineer—B.Ae.E., Rensselaer Polytechnic Institute. Age 22, single. Since July, 1945, connected with prominent East Coast light-plane producer as engineer. Experienced in structural design, aerodynamics, stress analysis, static testing, writing of reports for C.A.A. approval. Desires work associated with design and development of light planes. Associate member Sigma Xi, flying experience.

609. Executive and Aeronautical Engineer—Successful experience as Chief Engineer and in other responsible positions with major personal aircraft manufacturer. Well known by top industry and C.A.A. personnel; fully acquainted with C.A.A. procedure and operations and with industry methods and organization. Has also had successful management experience, and background of experience as ground instructor, pilot, A & E mechanic, navigator, radio operator, etc.; has thorough understanding of aviation from operator and private owner standpoint; and has acquired a sound working knowledge of factors affecting sales and advertising, purchasing, manufacturing, development, etc., with a keen insight into the industry's problems for the future.

603. Engineer—M.S. in A.E. Aircraft structures engineer, 26 years old, married. Has 2½ years' experience in the design of machine test equipment and 1½ years in responsible position as structures engineer for A.A.F. at Wright Field. Interested in position with Eastern or Midwestern aircraft company, or on staff of Eastern college. Qualified to teach mechanics, strength of materials, and airplane design.

600. Aeronautical Engineer-Pilot—Associate in Arts in Ae.E.; Chinese, 23 years of age, single. Cambridge Senior School Certificate (local), London, England. Experienced in layout, structural design, C.A.A. requirements, forging design. Has pilot's license and experience in maintenance of light aircraft and engines. Can translate French and Spanish (speaks both slightly), and speaks English fluently. Now Assistant Stress Analyst to Staff Engineer in well-known aircraft company. Desires engineering work with aviation company outside the United States. Willing to teach elementary engineering subjects. Will consider sales offer. Photograph, certificates sent on request.

599. Engineering or Management Executive—Engineer with 26 years' experience in aircraft engineering and manufacturing seeks responsible

engineering or management connection with aircraft manufacturer. Previous positions in $12,000 range. Outstanding design, organizing, and managing ability. Familiar with Army, Navy, and commercial requirements.

596. Technical Editor-Writer—Graduate Mechanical Engineer. Has 1 year's experience in operation of low-turbulence wind-tunnel testing airfoils, flaps, and ailerons. Also has 4 years' experience writing and editing technical training material consisting of description, operation, inspection, maintenance, and test of airplane engine, flight, and navigation instruments. Desires position as editor-writer of technical material.

594. Pilot-Engineer—Degrees in both Aeronautical and Mechanical Engineering. Three years' experience in flight test engineering and 1 year in wind-tunnel testing. Experience in both performance and flying qualities flight-test methods. Commercial pilot with single and multi-engined land ratings. Total time 1,700 hours with majority military in wide variety of types. Interested in flying or combination of flying and engineering in Middle West or West Coast aircraft company, preferably in connection with commercial-type aircraft.

590. Salesman—Age 26. Education in Eastern preparatory school and university. Three years' air-line engineering, domestic. Desires position in aircraft sales (airplanes and/or airplane parts). Excellent personal and business contacts.

589. Representative—Chinese, technical engineer with degrees in Ae.E. and M.E. Completed Army Air Forces A. and E. maintenance and pilot training. 3 years' factory experience in aircraft engine development works includes 1 year of jet propulsion and gas turbine. Formerly Government official. Desires responsible engineering position or representation to China.

588. Management or Administration—Twenty-seven years old, single, A.B. degree, University of Pennsylvania. Major in political administration, courses applicable to business administration. Courses in industrial engineering including industrial relations, business and government, organization and organizational structure. Aeronautical engineering courses in elementary aerodynamics, performance calculation, aircraft drafting and engineering. Two and one-half years in aircraft testing in present position. Desires permanent position on junior level in management or administration with opportunity for advancement. Philadelphia area.

587. Aeronautical Engineer—B.S. in Aeronautical and Mechanical Engineering. Five years' experience as aircraft service engineer, including overhaul, manufacturing, and aircraft modification. Ex-Marine Captain. New York area preferred.

585. Administrative—Air Force Major, staff intelligence officer. Age 31, married, college graduate. Five years' industrial experience prior to war. Desirable contacts in Philadelphia area. Some knowledge of German and French. Manufacturer's representative or agency.

580. Engineer—E.E. Seeks research, development, or administrative position in New York City or Long Island. Ten years' experience includes aircraft controls, ignition, servomechanisms and industrial electronics. Qualified to hold position requiring considerable administrative or supervisory ability. Will accept position of lesser responsibility with reasonable assurance of advancement.

578. Aeronautical Engineer—B.S. in M.E., aeronautical option, 1942. Four years' experience large-scale wind-tunnel testing and research work on propellers, air-cooled engine installation, airplane stability and control and general aerodynamics. Now engaged in supersonic flight-test work. Desires position in Middle West. Prefers research and development work in high-speed aerodynamics.

577. Sales Engineer—Graduate aeronautical engineer with 2½ years' experience in aircraft design engineering, including liaison, desires a position as sales engineer. No objection to foreign service.

576. Aeronautical Engineer—B.Ae.E. Age 26; married. Six years' experience. Group leader and project engineer for past 4½ years. Has done basic jet research and complete helicopter design. Desires position with responsibility in New York area.

572. Executive Assistant—Nine years' aviation background consisting of complete course in air-line operations, employment with major air line as meteorologist and trainee dispatcher, and command and important staff assignments in A.A.F. Additional training in basic engineering subjects, manufacturing and business administration; nonaviation experience in office management, selling, manufacturing and organizational consulting. Desires connection as assistant to air-line executive in operations or administration but will consider other positions where versatility and broad knowledge, plus dependability and mature thinking are required.

570. Maintenance Engineer—B.M.E., 1939. Five years' varied experience on transoceanic aircraft with air line. Accumulated 2,700 hours as flight engineer. Speaks Portuguese and German. Holds valid A & E and Private Pilot's license. One and one-half years with Army Air Transport Command. Interested in position with air line or with manufacturer designing transport aircraft.

569. Washington Representative—Reserve Officer and senior pilot desires to handle aviation concerns' Washington business. Fourteen years' industrial experience in aeronautical design, manufacture, testing, and operation of aircraft, engines, and accessories, plus 6 years' military duty in very responsible executive, engineering, and maintenance billets. Reliable, resourceful, and well established in Washington.

566. Graduate Engineer—Eight years' experience in materials and process, stress analysis, and structural testing. Desires position in similar or production field with aircraft, accessory manufacturer, or air line. Locality immaterial.

565. Engineer and Executive—Almost 30 years' experience on airplane and accessory design, airport selection and layout, and airplane operations engineering. Good organizer and manager, sound business experience, capable technical writer, wide knowledge of materials and processes.

560. Industrial and Aeronautical Engineer—B.S. in Industrial Engineering, major in Aeronautical Engineering from Iowa State College, 1943. Age 25. One year's experience with large West Coast aircraft concern. Served as an Aeronautical Engineering Specialist for over a year in the Navy Air Corps. At present, Production Officer at a Naval Air Station in charge of all repair shops and supervision of 400 men. Work includes checks, maintenance, repairs, and overhauls of latest-type Navy aircraft. Desires responsible position in the production department of an aircraft firm. Would also accept stress analysis or aerodynamicist position.

557. Aeronautical Engineer—B. of Aero.E., New York University and 2 years of law study. Four years' experience in static test and structural flight test experimental work on Naval aircraft. Experience in all phases of experimental work involving instrumentation and tests of aircraft structures. Plans to complete LL.B. degree in 1 year of evening school. One year part-time experience with patent attorney. Desires position in New York Metropolitan or Los Angeles area as patent engineer or aeronautical engineer. Opportunity desired for working into engineering-law position.

556. Production and Service Engineer—Nine years' practical experience in aircraft planning, scheduling, manufacturing processes, and service engineering with large eastern aircraft manufacturer. Experience includes planning and scheduling of production aircraft and spare parts, improvement and simplification of manufacturing processes, especially machining processes, and the compilation and editing of erection and maintenance manuals for production and experimental aircraft. Veteran of World War II. Desires position of administrative capacity in production management or service engineering.

553. Aeronautical Engineer—Canadian, age 28, married. Four years' responsible work in aircraft manufacturing and air-line engineering; previous writing and administrative experience. Broad educational background, including American. Thoroughly familiar with both American and British airworthiness requirements. Interested in development engineering. Continental or foreign location acceptable. West Coast preferred.

551. Aeronautical Engineer—General design experience on wood and metal aircraft, Army, Navy, and C.A.A. Considerable electrical and radio experience. Present standing Electrical and Radio Group Leader. Desires salaried position in vicinity of New York City.

547. Aeronautical Engineer—Assistant Professor of Aeronautical Engineering at large state university desires change. Has M.S. in Aeronautical Engineering; 8 years of teaching; industrial, consulting, and research experience in many phases of aeronautical engineering. Private pilot. Prefers university position with research and consulting possibilities. Will consider responsible industrial position.

546. Field or Sales Engineer—Seven years' experience in foreign and domestic field in installation and sales engineering for major engine company. Desires field or sales engineering position with engine or air-frame company. Well established contacts on West Coast and Buffalo area. References and background available upon request.

541. Translations—Aeronautical engineer and physicist would translate German technical papers and books into English. Thoroughly familiar with terminology in both languages.

540. Executive Accountant—Desires to join a progressive company as Treasurer, Controller or financial officer, or their chief assistant. Eight years' experience as Treasurer, Secretary. Also in plant management with one of the largest light-plane manufacturers. Has splendid banking connections. Desires to return to the aviation field. Willing to go to any part of the country, but prefers East or Middle West. Salary open, depending on future possibilities. Available within 30 days.

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533. Production Executive—Aeronautical Engineering degree, M.I.T. graduate. Industrial management experience. Eight and one-half years in the aeronautical field, including engineering design and layout, research and process, manufacturing and matériel, engineering officer U.S. Navy. Seeks executive or administrative post in field service and maintenance, factory and production management, matériel, or as line assistant to top executive. Available one month's notice.

532. Aeronautical Engineer—Bachelor of Aeronautical Engineering Degree from New York University with honors. Age 25. Two years' experience in design and research of aircraft propellers involving original administrative work on all phases of propeller design, theory, flight, testing, and production. Most original designs used by the services during the war. Flying experience. Two years' administrative experience as an officer in the U.S. Navy. Familiar with all phases of aviation. Desires responsible position in development, research, or administration in aeronautical organization with future. Has the initiative and ability to get things done. New York area preferred but not necessary. Excellent references.

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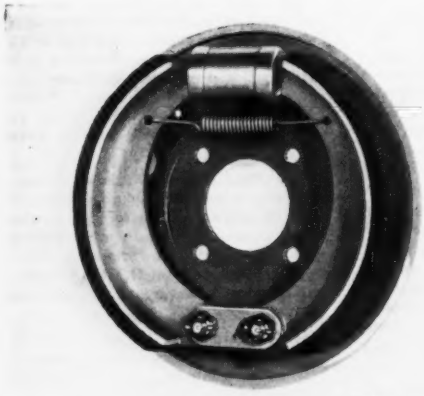
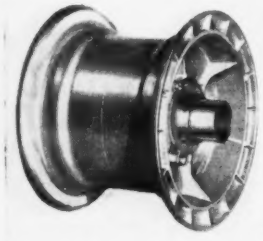


Above: Brake Assembly
Right: Wheel and Brake
Below: Nose Wheel
Right below: Master Cylinder and Parking Brake



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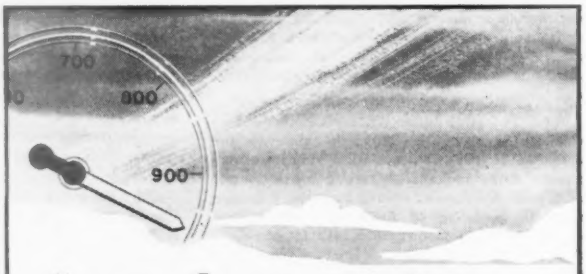

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530. Design Engineer—Seven and one-half years' well-rounded aircraft design experience, including 4 years' rotary wing. Engineering administrative experience. Three years' experience power plant; group leader, controls; group leader, preliminary design; design engineer, general. Location open.

524. Electrical and Aeronautical Engineer—Has done graduate work in electrical and aeronautical engineering. Four years' experience as Chief Inspection Supervisor of a leading aircraft factory. Certified Ground Engineer. Desires contact with interested aircraft manufacturers or air lines for business enterprise in the East.

523. Aeronautical Engineer—B.A.E., New York University. One year aeronautical research experience. Four years' stress analysis, liaison, design, production expediting with two large aircraft manufacturers. Familiar with aircraft fabrication practice. Desires responsible production management position.

Current Problems in Developing Major Components for Aviation Gas Turbines

(*Continued from page 35*)

power generation, etc., seem insignificant today. The answers to these obsolete controversies are readily apparent from our present knowledge. In aviation gas-turbine development there are sets of new controversies—propeller drive vs. jet, centrifugal vs. axial compressor, impulse vs. reaction turbine, annular vs. cellular combustion chamber, regenerator vs. none, etc. These are all very real and important to us today. They will all be answered in time, but the truly successful developer is he who first arrives at the conclusions that time will prove correct.

Before the worth of a projected engine can be evaluated, the performance of the engine under all conditions of operation must be known. To do this adequately, the performance of each of the major components must be evaluated over its complete range of operation. This can best be done by an analytical synthesis of experience. The performance of a specific compressor may be determined with remarkable accuracy before test if the proper synthesis of this performance is made from single or multistage experience on similar compressors. It is only by such a process that the best components to fit in with the overall requirements of the completed engine can be designed.

Conclusions

Tremendous strides have been made in the development of the aviation gas turbine since our entry into the last war. Gas-turbine powered planes that are in flight today are definitely superior for their specific applications than the best reciprocating types. Turbine engines greatly superior to those that have flown are in the final stages of their test stand development, while gas-turbine engines now on the drawing board show such promise that, when developed, they are expected to replace almost completely the reciprocating engine in man-carrying military planes.

The most important remaining current development problems may be summarized as follows. Considerable basic design must be amassed for the axial compressor in order to permit better compromises in the design of this important component, as well as to enable the preliminary engine designer to predict performance. A better understanding of the combined aerodynamic and mechanical mechanism of compressor blade failure must be reached to permit the lightest weight designs. Fundamental studies leading to a basic understanding of the combustion phenomena will have to be made before the size of the combustion chamber which is now critical from the standpoint of engine frontal area can be reduced. The turbine contains the two most important current development problems of the whole engine. The first is cooling and metallurgical improvements to permit operation at greatly increased cycle temperature and the second is a reduction of the leakage losses due to high running clearances now used. In the afterburning combustor, which is needed to fully exploit the potentialities of the turbojet engine, there is a problem of wall cooling to promote reasonable life. The main reduction gear development should be aimed at reducing weight while increasing life. In the reheat combustion chamber, when and if it is used, the important considerations will be life and size. The development of regenerators and intercoolers that are worth using for any appreciable number of aviation gas-turbine installations is in itself a major problem which may never be satisfactorily solved.

The importance of integrating the whole design of an engine from an aerodynamic and thermodynamic, as well as a mechanical point of view, should not be overlooked. The turbine-engine builder will do well to emulate the air-frame builder and design in great detail many engines for each one built.

If we look at the aviation gas turbine as envisioned by the most optimistic scientists a decade ago, it is already here with no major development problems left. Only if we set our sights higher still, which, of course, we must do, are the problems here discussed still with us.

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Guggenheim Estate Leased to the Navy	*Apr.*	31
Brig. Gen. Harold R. Harris Awarded Legion of Merit	*Feb.*	22
Honorary Members Elected	*Apr.*	31
Dr. Hunsaker Elected Director of Goodyear Tire & Rubber Company	*Oct.*	6
Dr. Hunsaker Elected Director of Two Companies	*June*	21
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I.A.S. Honors Night Dinner and Annual Meeting Planned	*Nov.*	5
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I.A.S. Members on Executive Board of N.Y. Board of Trade	*July*	8
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Grover Loening Elected to Guggenheim Board	*July*	8
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Medal of Freedom Awarded Dr. Dryden	*Dec.*	8
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T. P. Wright Receives Medal of Freedom	*July*	8
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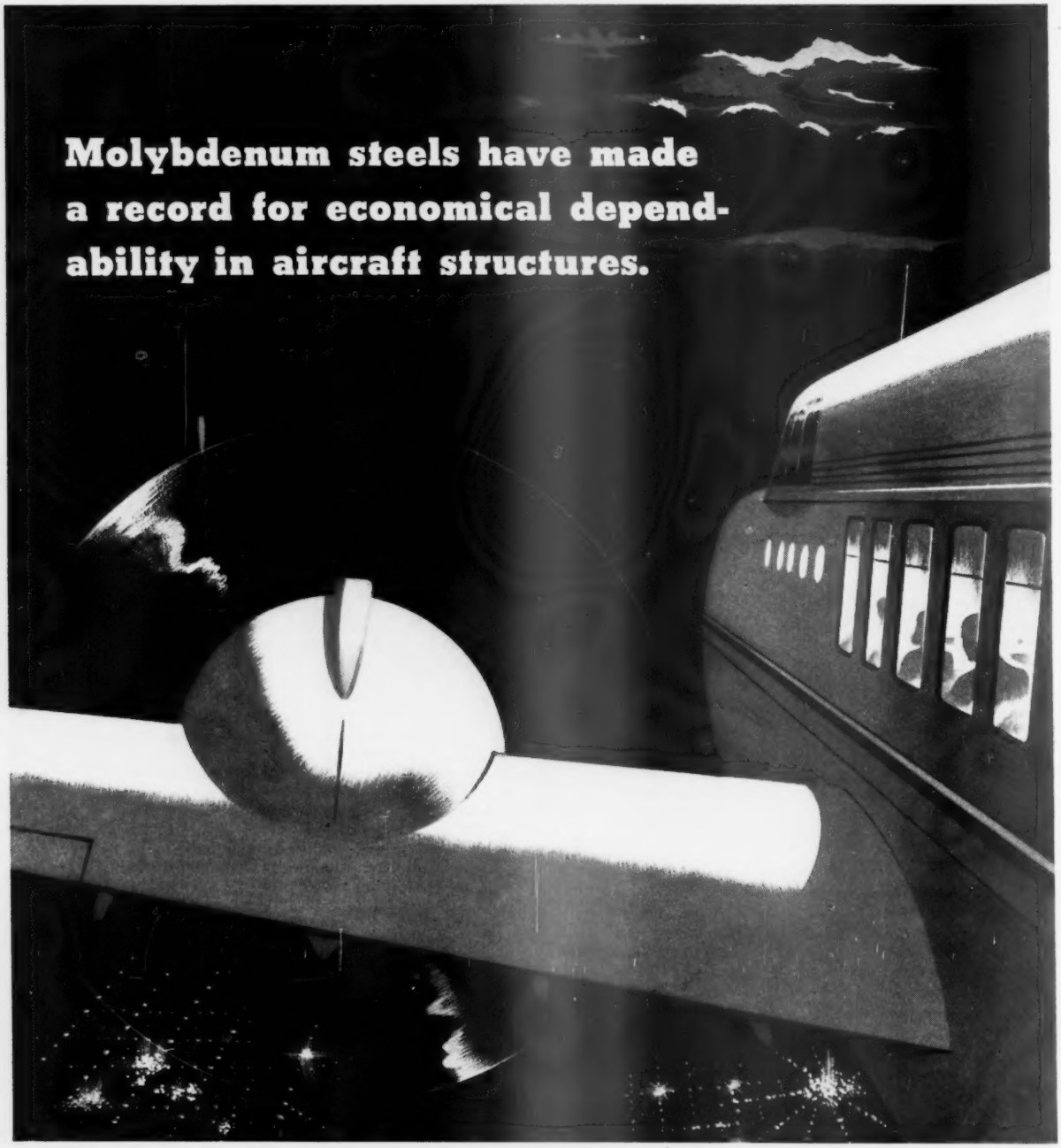

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I.A.S. National Meeting Schedule

Fifteenth Annual Meeting—New York, N.Y., Hotel Astor —January 28–29–30, 1947

Aircraft Propulsion Meeting—Cleveland, Ohio, Carter Hotel—March 28, 1947

Light Aircraft Meeting—Detroit, Mich., Horace H. Rackham Educational Memorial—May 26–27, 1947

The Meetings Committee of the Institute invites participation in the technical sessions of the Aircraft Propulsion and Light Aircraft meetings.

Members or organizations wishing to submit papers for these meetings should send complete papers, or outlines or summaries, to the Meetings Committee at least three months prior to the meeting. Outlines or summaries should not exceed 1,000 words.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to The Meetings Committee, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

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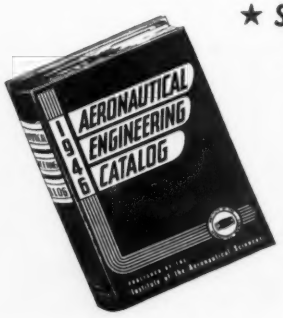

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